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SOLVING HOMELAND SECURITY'S WICKED PROBLEMS: A DESIGN THINKING APPROACH

by

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September 2015

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The Department of Homeland Security's Science and Technology Directorate (DHS S&T) requires a consistent yet flexible approach to address wicked problems. A design-thinking methodology holds promise, as its tenets align with the diversity and complexity inherent within the homeland security environment. Design thinking emphasizes a human-centered and multidisciplinary approach to solution development. The research examined how design thinking is used to solve problems, S&T's current approach to solving problems, and how other public organizations are using a design-thinking methodology. Denmark's MindLab and the Defense Advanced Research Projects Agency (DARPA) informed a framework for how DHS S&T could adopt a design-thinking approach. The analysis and framework were organized around Galbraith's Star Model. The conclusion is that a design-thinking approach requires a significant shift in how S&T executes research and development (R&D). This shift can strengthen the dialogue necessary between S&T, homeland security practitioners, and nontraditional DHS partners to spur solutions. This thesis provides a framework for how S&T can incorporate design-thinking principles that are working well in other domains to tackle homeland security's complex problems.

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SOLVING HOMELAND SECURITY'S WICKED PROBLEMS: A DESIGN THINKING APPROACH

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ABSTRACT

The Department of Homeland Security's Science and Technology Directorate (DHS S&T) requires a consistent yet flexible approach to address wicked problems. A design-thinking methodology holds promise, as its tenets align with the diversity and complexity inherent within the homeland security environment. Design thinking emphasizes a human-centered and multidisciplinary approach to solution development. The research examined how design thinking is used to solve problems, S&T's current approach to solving problems, and how other public organizations are using a design-thinking methodology. Denmark's MindLab and the Defense Advanced Research Projects Agency (DARPA) informed a framework for how DHS S&T could adopt a design-thinking approach. The analysis and framework were organized around Galbraith's Star Model. The conclusion is that a design-thinking approach requires a significant shift in how S&T executes research and development (R&D). This shift can strengthen the dialogue necessary between S&T, homeland security practitioners, and nontraditional DHS partners to spur solutions. This thesis provides a framework for how S&T can incorporate design-thinking principles that are working well in other domains to tackle homeland security's complex problems.

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LIST OF ACRONYMS AND ABBREVIATIONS

ARPA-E	Department of Energy's Advanced Research Project Agency—Energy
CDS	Capability Development Support
CRS	Congressional Research Service
DARPA	Defense Advanced Research Projects Agency
DHS	Department of Homeland Security
DOD	Department of Defense
FRG	First Responder Group
GAO	Government Accountability Office
HSARPA	Homeland Security Advanced Research Projects Agency
HSE	homeland security enterprise
IARPA	Office of the Director of National Intelligence's Intelligence Advanced Research Projects Agency
IPT	integrated project team
OPM	Office of Personnel Management
PM	program manager
QHSR	Quadrennial Homeland Security Review
R&D	research and development
RDP	Research and Development Partnerships
S&T	DHS Science and Technology Directorate
SELC	systems engineering life cycle
STEM	science, technology, engineering, and mathematics
TITAN	Targeted Innovative Technology Acceleration Network
USAID	U.S. Agency for International Development (USAID)

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EXECUTIVE SUMMARY

The Department of Homeland Security's Science and Technology Directorate (DHS S&T) requires a consistent yet flexible approach to address wicked problems. While design thinking can be applied to any problem, it lends itself to "wicked problems" that cannot be definitively described or solved.[1] Wicked problems require a multidisciplinary approach and a shared understanding and commitment around a problem to identify and develop solutions. Examples of wicked problems include impacts of climate change, evolving terrorist threats, and cyber security within an increasingly connected cyber and physical world. While design thinking is not a new concept, its recent manifestation within the private and public sectors to include organizations, such as Apple, Google, IBM, and the governments of Singapore and the United Kingdom, warrants attention to how it may address homeland security's complex problems. A design-thinking methodology holds promise for DHS S&T as its tenets align with the diversity and complexity inherent within the homeland security environment. Design thinking emphasizes a human-centered and multidisciplinary approach to solution development that supports DHS S&T's mission to identify and transition cutting-edge solutions to homeland security operators.

A. RESEARCH QUESTION

This thesis answers the question of how DHS S&T could adopt a design-thinking approach to solve complex problems. The research specifically examined how design thinking is used to solve problems, S&T's current approach to solving problems, and how other public organizations are using a design-thinking methodology.

B. METHOD AND DESIGN

The research approach involved a comparative analysis of case studies. The first case study reviewed the use of design thinking within Denmark via the MindLab. The second study reviewed Defense Advanced Research Projects Agency's (DARPA's)

[1] Horst W. J. Rittel and Melvin M. Webber, "Dilemmas in a General Theory of Planning," *Policy Sciences* 4, no. 2 (June 1, 1973): 155–69. doi:10.1007/BF01405730.

approach to problem identification and solution through a design-thinking lens. Galbraith's Star Model was used to analyze how DHS S&T, MindLab, and DARPA apply design-thinking principles to inform the framework to apply and incorporate design thinking within DHS S&T's approach to R&D. The Star Model consists of five areas that in conjunction with one another can influence an organization's culture and individual behaviors.

C. CONCLUSION

Rather than a passing trend, an in-depth review of design thinking coupled with the case studies confirms the promise the approach could bring to DHS S&T. A design-thinking approach requires a significant shift in how S&T executes research and development (R&D). This shift can strengthen the dialogue necessary between S&T, homeland security practitioners, and nontraditional DHS partners to spur solutions. This thesis provides a framework for how S&T can incorporate design-thinking principles that are working well in other domains to tackle homeland security's complex problems. While the basic tenets of design thinking remain consistent across the literature, it is noted that successful adopters of a design-thinking approach define it according to their own terms and factor their organization's culture into its implementation. By reviewing aspects of design thinking through the Star Model, a holistic approach is provided for S&T to consider how design thinking can be customized to best align with its mission, values, and workforce to spur new approaches to discovering and developing solutions to homeland security. To support the homeland security enterprise (HSE), DHS S&T must be able to refine and improve tools and processes continually, think outside of traditional solutions, adapt quickly, and work across disciplines and geographic areas. A design-thinking model could impact projects immediately and positively shape the organization's culture over time.

A strong and consistent relationship with end users and partners across disciplines has remained elusive for DHS S&T. A design-thinking approach emphasizes communication and a shared understanding of a problem to identify multiple solutions. By emphasizing the end use of a product or service, design thinking holds the promise of

improving DHS's rate of technology transition and impact on the homeland security and resilience. While the research question focused on DHS S&T, it is hoped other organizations may be able to apply the practices captured within their own organizations.

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I. INTRODUCTION

A. RESEARCH QUESTION

This thesis answers the question of how DHS S&T can adopt a design-thinking approach to address wicked problems.

B. PROBLEM STATEMENT

To prepare for emerging threats, the Department of Homeland Security's Science and Technology Directorate (DHS S&T) requires a consistent yet flexible approach to produce innovative solutions to wicked problems. A design-thinking methodology holds promise for DHS as its tenets align well with the diversity and complexity inherent within the homeland security environment. Design thinking emphasizes a human-centered and multidisciplinary approach to solution development that supports DHS S&T's mission to identify and transition cutting-edge solutions to homeland security operators.

However, a design approach requires a shift in how S&T executes research and development (R&D) programs. This thesis proposes a framework derived from case studies for how a design-thinking methodology can be applied to DHS problem sets. The model addresses the perceived benefits of design thinking, as well as addresses potential limitations. A design-thinking approach to R&D can strengthen the dialogue necessary between DHS S&T, homeland security practitioners, and nontraditional DHS partners to spur innovative solutions.

DHS S&T spends nearly a billion dollars a year to address complex homeland security problems.[1] DHS S&T wrestles with an expansive mission, an evolving research and development (R&D) landscape no longer driven by the Federal Government, and rapid advancement of transformative technologies. The R&D community is seeing an increase in industry R&D spending compared to government R&D spending, making it imperative to build new partnerships within and outside of government to leverage investments and ideas. The advancement of transformative technologies, coupled with

[1] While DHS S&T's budget averages $1 million per year, approximately 50% is non-discretionary funding to build, maintain, and operate national laboratories.

their exponential growth, is changing the speed of and approach to innovation. This exponential growth also requires that the government anticipate and address policy implications as policies frequently prevent new technology from making the intended impact. These shifts within the R&D community provide an opportunity to rethink traditional approaches to security and resilience challenges.[2] Requisite for harnessing these opportunities is the ability to coordinate and collaborate across disciplines, organizations, and geographical boundaries to identify, rethink, and quickly address pressing needs.[3]

Design thinking is a methodology embraced by many government and private sector organizations to spur innovative solutions to complex problems. It employs a holistic, agile, and human-centered approach to innovation. Razzouk and Schute define design thinking as "an analytic and creative process that engages a person in opportunities to experiment, create and prototype models, gather feedback, and redesign."[4] Braha and Maimon state that design science is a collection of logically connected knowledge and disciplines.[5] Owen offers that design thinking is most effective when used by a multidisciplinary team comprised of individuals with different values and training.[6] Design thinking as a practice has been adopted by corporations, such as Apple, Google, and IBM, the governments of Denmark and Singapore, and can be glimpsed in government organizations, such as the Defense Advanced Research Projects Agency (DARPA). While design thinking can be applied to any problem, it lends itself to "wicked problems." As defined by Rittel, a wicked problem cannot be definitively

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[2] Peter H. Diamandis and Steven Kotler, *Abundance: The Future Is Better Than You Think* (New York: Free Press, 2012), Kindle edition, 280–283.

[3] Department of Homeland Security, *The 2014 Quadrennial Homeland Security Review* (Washington, DC: Department of Homeland Security, 2014).

[4] Rim Razzouk and Valerie Shute, "What Is Design Thinking and Why Is It Important?" *Review of Educational Research* 82, no. 3 (September 1, 2012): 330–48. doi:10.3102/0034654312457429.

[5] Dan Braha and Oded Maimon, "The Design Process: Properties, Paradigms, and Structure," IEEE Transactions on Systems, Man, and Cybernetics—Part A: Systems and Humans 27, no. 2 (March 1997), http://necsi.edu/affiliates/braha/IEEE_TSMC_Design_Process.pdf.

[6] Charles L. Owen, "Design Thinking: Driving Innovation," *The Business Process Management Institute*, September 2006, https://methods.id.iit.edu/media/cms_page_media/200/owen_desthink06.pdf.

described, and no definitive solutions are available.[7] Wicked problems require a multidisciplinary approach and a shared understanding and commitment around a problem to identify solutions. Examples of wicked problems include impacts of climate change, evolving terrorist threats, and cyber security within an increasingly connected cyber and physical world. While design thinking is not a new concept, its recent manifestation within the private and public sectors warrants attention to address homeland security's wicked problems.[8]

C. LITERATURE REVIEW

The literature review provides an overview of design thinking and how it may apply to homeland security challenges. This review also summarizes the prevailing methods used by DHS to identify and address homeland security problems. The review then turns to examples of public-sector use of design thinking to identify opportunities for DHS. Additionally, organizational management literature was reviewed to inform the factors used for the subsequent case study analysis of two public sector organizations to identify a framework for DHS S&T to incorporate design thinking within the organization.

1. What is design thinking and how is it used to solve problems?

a. Design Thinking Approach

At its core, design thinking is a repeatable process that spurs creativity to solve complex problems in new ways. Rather than attribute creativity to the select few or the lucky, design thinking proposes specific methods that can be used by anyone. In his 1969 book, *The Sciences of the Artificial*, Simon proposes a group of cognitive processes related to creativity to frame the science of design. Expanding on Simon's work, McKim introduced visual imagery as a tool to enable creative thinking in design engineering.[9] In

[7] Rittel and Webber, "Dilemmas in a General Theory of Planning," 155–69.

[8] DHS Science and Technology Directorate, *Strategic Plan 2015–2019* (Washington, DC: DHS Science and Technology Directorate, 2015).

[9] Robert McKim, *Experiences in Visual Thinking*, 2nd ed. (Monterey, CA: Brooks/Cole Publishing Company, 1980).

the 1980s, Faste popularized the concept of "design thinking" and design education. Design thinking is a method to realize concepts and ideas and rationalize how different solutions may fit within the problem context.

The design approach differs from the more traditional linear approach of defining all parameters of a problem to create a solution. Design thinking embraces appreciative inquiry and posits that by starting with a shared vision for a better future state, alternative solutions may be explored simultaneously. Another feature of a design-thinking methodology is flexibility. Since design thinking is an iterative process, intermediate solutions provide alternatives to include potentially redefining the problem.[10] Akin maintained the view that the less a problem is understood, the more degrees of freedom afforded resulting in less dependence on known solutions.[11]

Razzouk and Schute define design thinking as "an analytic and creative process that engages a person in opportunities to experiment, create and prototype models, gather feedback, and redesign."[12] This definition acknowledges that design thinking requires analysis, as well as synthesis and supports the notion that design thinking may provide a foundation for scientists to engage with homeland security practitioners to develop solutions. In 1972, designer and educator Victor Papanek wrote, "All men are designers. All that we do, almost all the time, is design, for design is basic to all human activity…Any attempt to separate design, to make it a thing-by-itself, works counter to the fact that design is the primary underlying matrix of life."[13]

b. Design-Thinking Process

Figure 1 provides a common process flow and terminology associated with design thinking. The steps reflect those promoted by the Institute of Design at Stanford

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[10] *Wikipedia*, s.v. "Design Thinking," last modified August 29, 2015, https://en.wikipedia.org/wiki/Design_thinking.

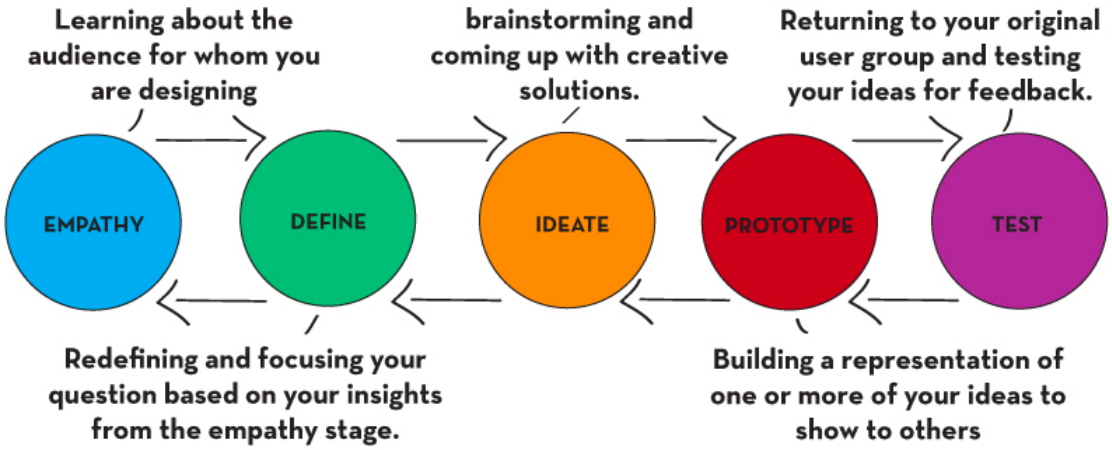
[11] Ömer Akin, "Creativity in Design," *Performance Improvement Quarterly* 7, no. 3 (September 1, 1994): 9–21. doi:10.1111/j.1937-8327.1994.tb00633.x.

[12] Razzouk and Shute, "What Is Design Thinking and Why Is It Important?"

[13] Victor Papanek, *Design for the Real World: Human Ecology and Social Change*. 2nd ed. revised. (Chicago: Chicago Review Press, 2005).

(d.school) to include the step descriptions. The figure emphasizes the iterative nature of the design-thinking process.

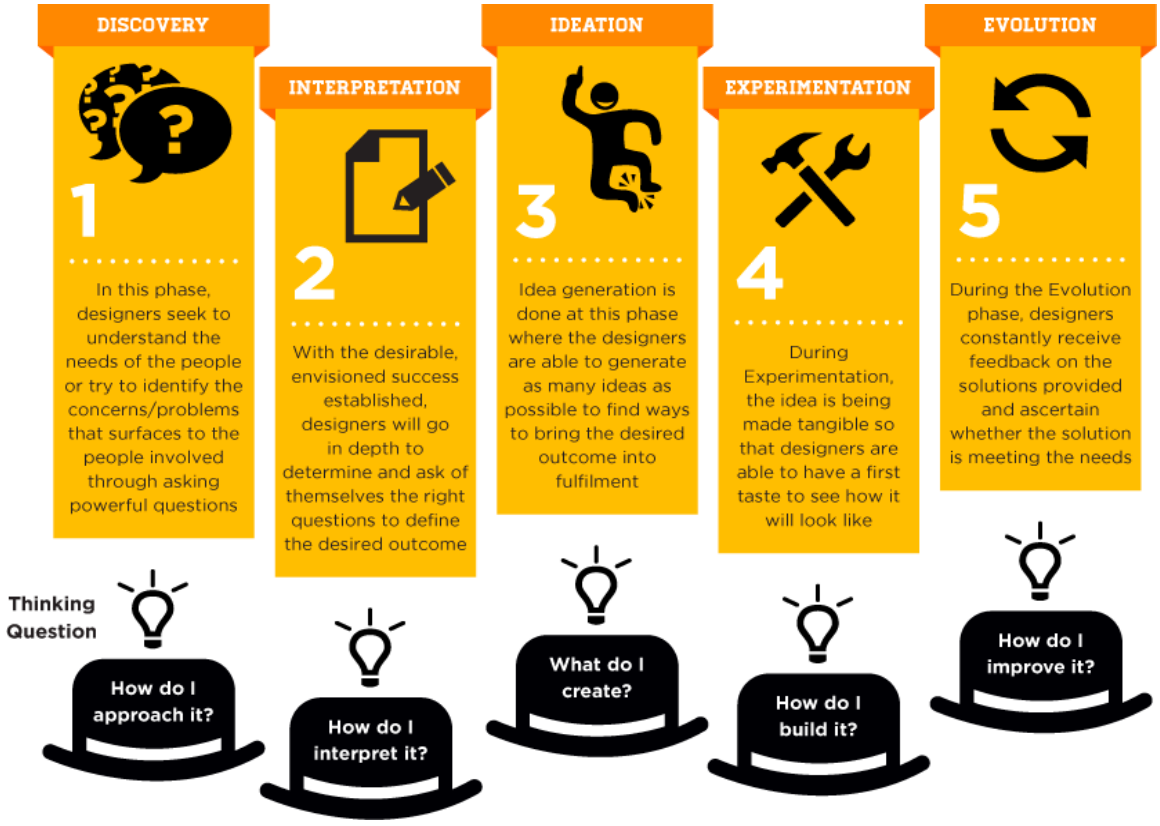
Figure 1. Design Thinking Process Overview



From "Design Thinking," accessed August 16, 2015, http://createdu.org/design-thinking/.

Many depictions of the design-thinking process exist; however, the five basic steps are consistently represented. For example, Figure 2 uses different terms to describe the phases but the description and intent of each remains the same. A series of figures were reviewed that graphically represent the design-thinking methodology. The takeaway is that the design process is malleable and consists of principles that can be tailored to an individual organization or audience; the use of various graphics illustrates that at its center, design thinking is about using all available forms and mediums to connect with a given audience.

Figure 2. Design Thinking Process Overview—Alternate View



From "Design Thinking|Engaging Hearts and Minds for Critical Thinking," accessed August 16, 2015, http://www.lifeskills-enrichment.com.sg/portfolio/designthinking/.

c. Design Thinking Team Construct

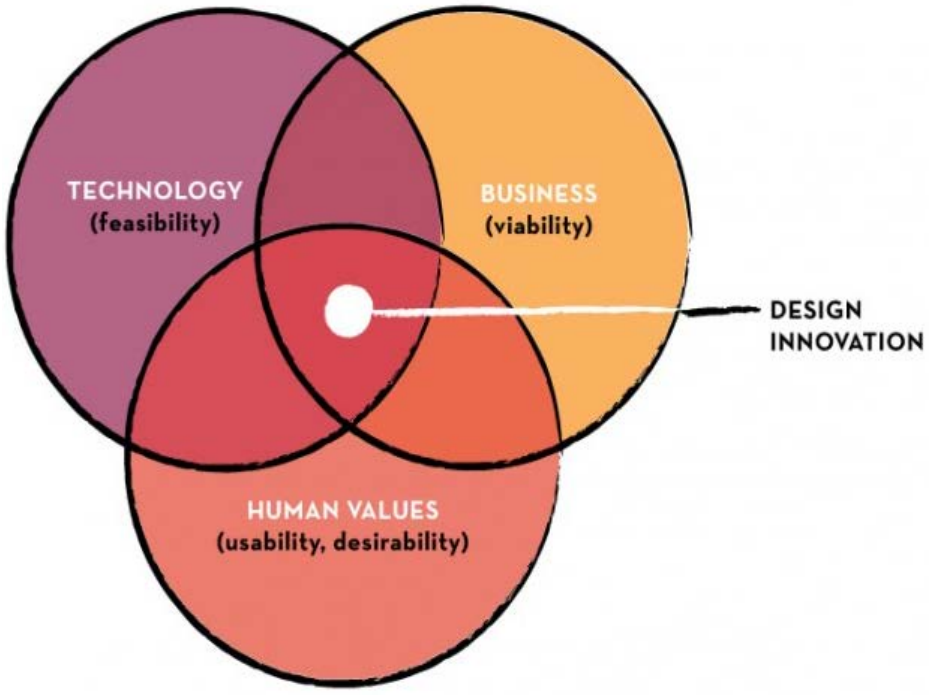
Braha and Maimon state that design science is more or less a collection of many different logically connected knowledge and disciplines.[14] Owen elaborates that a design approach is most effective when exercised in conjunction with a multidisciplinary team comprised of individuals "with different values and training—from the physical sciences, arts, political and social sciences, engineering, business, etc."[15]

Figure 3 illustrates the intersection at which design innovation is likely to occur and the inclusion of varying perspectives to achieve innovation:

[14] Braha and Maimon, "The Design Process: Properties, Paradigms, and Structure,"

[15] Owen, "Design Thinking: Driving Innovation,"

Figure 3. Design Innovation



From "Our Point of View," accessed August 16, 2015, http://dschool.stanford.edu/our-point-of-view/.

Owen offers three ways that design can be incorporated: through consultancy, by adding a design professional to a project team, or a systemic approach in which each team member learns and practices design values.[16] As the homeland security enterprise (HSE) is built on a multitude of disciplines, design thinking may provide a useful methodology to ensure the depth and breadth of expertise is fully engaged, heard, and used.

d. Design Thinking Challenges

Design thinking is not without its critics, although the critics caution more about the implementation of the process rather than the process itself. For example, Bruce Nussbaum is concerned with the tendency to consider design thinking as a process "trick" to produce significant cultural and organizational change. His words serve as a reminder that rather than a definitive process, design thinking should be viewed as a framework

[16] Owen, "Design Thinking: Driving Innovation."

that enables creativity. He observes that to appeal to the business culture of process, the messy conflict and looping circularity of the creative process can be lost. Those organizations that accept the mess achieve real innovations, and those that do not accept the mess do not reap the rewards of the design-thinking process.[17]

As Nussbaum notes, promoting creativity is at the heart of design thinking and any organization must be careful not to overemphasize the process at the risk of stifling the creativity the framework is intended to foster. The literature provides a variety of methods and it could be proposed that a combination of techniques tailored to an organization or problem set may result in the holistic view necessary to open the aperture to new solutions. Furthermore, by viewing a problem as part of a larger ecosystem, opportunities for innovations that may address multiple problems may appear.

e. Stewardship

In addition to adherence to an overly rigid process, another challenge is the ultimate implementation of proposed solutions. The Global Centre for Public Service Excellence points out that design thinking is intimately linked with the notion of "stewardship."[18] It defines stewardship as an ability to translate ideas successfully into practice to achieve desired outcomes.[19] They propose the term and definition of stewardship is more useful than the terms "implementation" or "execution." The Centre supports Nussbaum's view that to operationalize a designed idea within a complex environment demands agility rather than strict adherence to a set plan or rigid process. Stewardship requires a balancing act in that the government is able to react to unexpected developments while staying on course to meet set priorities and outcomes.[20]

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[17] Bruce Nussbaum, "Design Thinking Is a Failed Experiment. So What's Next?" Co.Design, April 5, 2011, http://www.fastcodesign.com/1663558/design-thinking-is-a-failed-experiment-so-whats-next.

[18] Lorenzo Allio, *Design Thinking for Public Service Excellence* (Singapore: Global Centre for Public Service Excellence, 2014), http://www.undp.org/content/dam/uspc/docs/GPCSE_Design%20Thinking.pdf.

[19] "What Is Positive Deviance," 2014, http://www.positivedeviance.org.

[20] Global Centre for Public Service Excellence, *Design Thinking for Public Service Excellence* (Singapore: Global Centre for Public Service Excellence, 2014).

f. Organizational Considerations

An emerging organizational construct for a design-thinking methodology is innovation labs. Innovation labs reflect the skunkworks concept. Rogers defines skunkworks as "an especially enriched environment that is intended to help a small group of individuals design a new idea by escaping routine organizational procedures. The R&D workers in a skunkworks are usually specially selected, given special resources, and work on a crash basis to create an innovation."[21]

Steve Blank argues that while skunkworks provided advantages to organizations in the past by mirroring a startup, organizations now need to integrate innovation within their operations so innovation and execution are working in tandem to remain competitive and effective.[22] He proposes the solution is developing parallel processes for innovation and execution recognizing that innovation-related projects often run into hurdles with established processes related to human capital, project tracking, and legal implications.[23]

As DHS S&T reviews its innovation and execution functions, it may be worthwhile to pay attention to how other public organizations are practicing innovation-related activities within their organizations. Clayton Christensen states, "with few exceptions, the only instances in which mainstream firms have successfully established a timely position in a disruptive technology were those in which the firms' managers set up an autonomous organization charged with building a new and independent business around the disruptive technology."[24] A review of how other public organizations address the structural challenge of promoting innovation while executing other responsibilities may provide insight for DHS S&T.

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[21] Everett M. Rogers, *Diffusion of Innovations*, 5th ed. (New York: Free Press, 2003).

[22] Steve Blank, "Why Corporate Skunk Works Need to Die," *Forbes*, accessed April 19, 2015, http://www.forbes.com/sites/steveblank/2014/11/10/why-corporate-skunk-works-need-to-die/.

[23] Steve Blank, "Getting to 'Yes' For Corporate Innovation," *Forbes*, accessed April 19, 2015, http://www.forbes.com/sites/steveblank/2015/03/16/getting-to-yes-for-corporate-innovation/.

[24] Clayton Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail (Management of Innovation and Change)* (Watertown, MA: Harvard Business Review Press, 2013), Kindle edition.

g. Design Thinking and the Individual

The macro/micro universal law of change states, "the maximum speed of change is always faster at the macro level of economic and political systems than it is at the micro level of psychological characteristics of people."[25] The successful implementation of macro ideas, such as open innovation and design thinking, are dependent on micro foundations to include the workforce and how individual employees embrace new methodologies and practices. For example, it is relatively simple for a leader to proclaim innovation as a priority and that project risk is acceptable. It is more difficult to motivate and empower individuals to change the way they execute projects.

Razzouk and Shute state, "although the design process involves in-depth cognitive processes... it also involves personality and dispositional traits such as persistence and creativity."[26] While an individual should take responsibility for developing new skills, the organization plays a key role in nurturing persistence and creativity through leadership, training opportunities, support elements, incentives, and recruiting.

Downey et al. propose that the "knowledge, ability, and predisposition to work effectively with people who define problems differently than they do" should be considered a global competency for engineering students.[27] They posit a renewed emphasis on working across cultures. While the authors focus on culture defined by country, their work can also apply to cultures found within different geographic areas within a country, such as the United States or across disciplines. The nature of the DHS mission requires coordination and collaboration across geographic boundaries and disciplines.

Salter, Criscuolo, and Wal state that for many organizations, the notion of open innovation has not been successful due to organizational barriers that prevent individual

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[25] Fathali M. Moghaddam, *From the Terrorists' Point of View: What They Experience and Why They Come to Destroy* (Santa Barbara, CA: Greenwood Publishing Group, 2006).

[26] Razzouk and Shute, "What Is Design Thinking and Why Is It Important?" 330–48.

[27] Gary Lee Downey et al., "The Globally Competent Engineer: Working Effectively with People Who Define Problems Differently," *Journal of Engineering Education* 95, no. 2 (April 2006): 107–22.

employees from shifting their approach. As organizations encourage employees to engage with a diverse set of partners to improve and create products, processes, and services, an organization should be prepared to redefine internal processes and boundaries. They argue that the same if not more attention is needed for an organization's "internal face" as to its "external face."[28]

Salter, Criscuolo, and Wal argue that while organizations are aware of the role of individuals in open innovation, most of the literature focuses on the organization rather than the individual.[29] Their position is that by understanding the challenges and coping mechanisms that R&D professionals face when practicing open innovation type activities, organizations can take specific steps and create systems within the organization to help individuals become more effective open innovators and problem solvers.[30]

h. Metrics

A common theme within the literature is identifying desired outcomes and related metrics before embarking on a project. While metrics are important for a project regardless of the methodology used, design thinking may lend itself to a few unique metrics. Whereas DHS S&T defines success on whether at the end of a project it transitioned to an end user, design thinking emphasizes the process used to arrive at a solution. Simon, Gupta, and Buchanan introduce a series of questions that may be useful to gauge the impact of a shift to design thinking:

- Toward a particular goal, how many ideas did the team try? (More is better)
- How many sources of inspiration (outside the team) were tapped?
- What is the average time between having an idea, and testing it with potential users?

[28] Ammon Salter, Paola Criscuolo, and Anne L. J. Ter Wal, "Coping with Open Innovation: Responding to the Challenges of External Engagement in R&D," *California Management Review* 56, no. 2 (Winter 2014): 77–94. doi:10.1525/cmr.2014.56.2.77.

[29] Ibid.

[30] Ibid.

- How many "cycles" of improvement did a team accomplish before executing an idea?
- How many others are calling your team for insights and help?[31]

i. Gaps

While leaders in the design-thinking space, such as IDEO and Stanford, are recognized, organizations have room to grow to synthesize the components of design thinking and tailor their application to their respective organizations. A review of design-thinking literature implies that design thinking is less of a "how to guide" and more of a cultural shift for how individuals work together to identify solutions. While innovation labs are becoming popular, significant research has not been conducted to gauge their success in the public sector. The reviewed literature did not provide specific examples of homeland security application of design thinking, nor was a specific public sector framework posed although innovation labs are referred to frequently and appear to be grounded in design thinking.

2. What is S&T's current approach to problem solving?

a. S&T Organization

The DHS S&T Under Secretary is supported by four groups within DHS S&T. The Homeland Security Advanced Research Projects Agency (HSARPA) and the First Responder Group (FRG) execute R&D programs in support of HSE needs. The Capability Development Support (CDS) Group and the Research and Development Partnerships (RDP) Group support the technical divisions in the identification, formulation, selection, and execution of R&D programs and products. In addition, an Office of the Chief Scientist is charged with providing technical expertise for S&T programs and an Office of the Chief Financial Officer that uses a separate set of processes to determine funding priorities and budgets for S&T projects. Leadership within each of these groups oversee individual or duplicate aspects of project

[31] Tad Simons, Arvind Gupta, and Mary Buchanan, "Innovation in R & D: Using Design Thinking to Develop New Models of Inventiveness, Productivity and Collaboration," *Journal of Commercial Biotechnology* 17 (August 23, 2011): 301–7. doi:10.1057/jcb.2011.25.

management to include new project approvals, periodic portfolio reviews, technology transfers, and engagement with practitioners and senior officials throughout government and the HSE.

b. S&T Processes

A consistent set of project management processes and programs is not uniformly adopted across DHS S&T. The continual change in leadership since the organization's inception poses challenges, coupled with an increasingly constrained fiscal environment. The lack of processes and consistency provides an opportunity to shape how the organization executes R&D moving forward but also poses a challenge, as no recognized baseline is available to work from and to communicate specific changes warranted by a design-thinking approach clearly.

Two existing S&T process documents are the DHS Acquisition Guide, which includes a Systems Engineering Annex, and an S&T Project Management Guide. These documents are primarily derived from the systems engineering life cycle (SELC). In 2013, an S&T Systems Analysis Guide was published but never fully implemented.[32] An effort is underway to develop a Capability Development Framework; this document was specifically designed for a series of six programs. Each of these documents tends to be written in the language of the discipline authoring the guidance and may not be digestible by the myriad disciplines and players within and outside of the homeland security community. While the guides provide useful information and structures, the processes are comprised of many linear steps and are documentation intensive. Coupled with the predominant use of traditional contract vehicles, the problem definition, acquisition, and development process can be lengthy in S&T. The FRG and HSARPA maintain their own processes for project management. In addition, various S&T offices to include capability development support offices, office of university programs, office of national labs, federally funded research and development centers, and international programs maintain separate project initiation and execution processes. Most of these documents are created

[32] DHS Science and Technology Directorate, *Systems Analysis Guidebook* (Washington, DC: DHS Science and Technology Directorate, 2013).

independently and are not coordinated and implemented across the organization, nor are key project management principles communicated to provide an overall theme for how S&T program managers approach projects.

While R&D is the backbone of S&T, the organization is also responsible for activities beyond those of a traditional R&D organization. Along with driving innovation to solve homeland security challenges, the Directorate is also responsible for DHS-wide acquisition and test and evaluation activities. These latter activities cause challenges with regard to how DHS S&T prioritizes resources, manages portfolios, and communicates and executes projects. It can be argued that the existing guides provide for flexibility by including references to spiral development and prototype development in addition to the traditional waterfall development; however, the number of gates and justifications required to move forward temper the implied flexibility.[33]

In addition to these more formal and documented processes, multiple attempts have been made in recent years to introduce new processes to spur more innovative project ideas and promote competition within S&T. Elements of DARPA's new start process (as understood by individual DHS S&T staff members) were introduced, but not adopted. A topic that warrants attention is the need for consistency in processes over a period of time to support adoption by the organization and to gauge results and allow for necessary adjustments.

c. Goals and Objectives

In the 2015 *DHS S&T Strategic Plan*,[34] Under Secretary Brothers highlights a series of activities to position DHS S&T as a leader within the R&D community. The primary focal points for the strategy are engagement with operators, engagement with industry, and an energized workforce. These focal points are deemed necessary to impact the homeland security mission through the introduction of new technologies. While new programs are described to include innovation centers, prize authority, and the Targeted

[33] Department of Homeland Security, *DHS Acquisition Instruction/Guidebook* (Washington, DC: Department of Homeland Security, 2008), https://learn.test.dau.mil/CourseWare/803897_3/pdfs/Appendix_B_Systems_Engineering_Life_Cycle_%28SELC%29_-_Interim_v1_9_dtd_11-07-08.pdf.

[34] DHS Science and Technology Directorate, *Strategic Plan 2015–2019*.

Innovative Technology Acceleration Network (TITAN), an opportunity exists to refine and ensure the new programs are defined, linked, and effectively executed to achieve the stated mission and objectives within the *Strategic Plan*.[35] The collaborative and user centered principles of design thinking align well to S&T's current strategic direction.

d. Problem Definition and Communication

A series of activities has been initiated by DHS to connect with partners and operators; however, a common understanding of how activities complement one another and the creation of measures to gauge impact could increase impact. A consistent approach to how S&T engages end users to identify and prioritize problems could improve S&T's ability to communicate and connect with traditional and nontraditional partners for solutions and to anticipate disruptive innovations. The design-thinking process and related tools could assist DHS S&T with problem definition and communication.

e. Mission Impact

The 2014 report, *The DHS S&T Directorate: Selected Issues for Congress*, notes that DHS S&T has experienced significant challenges in transitioning knowledge products and technology into operational environments.[36] DHS S&T is expected to identify, develop, and deliver effective and innovative insight, methods, and solutions. The Global Centre for Public Service Excellence notes in the guide *Design Thinking for Public Service Excellence*, "A good idea is relevant only if it is converted into a concrete public policy decision…design thinking…stretches over adoption into the implementation and review phases of the policy cycle."[37]

A review of technology adoption-related literature identifies two theories that can contribute to DHS's understanding of how to improve the likelihood that a new solution will be used by end users. In addition, technology adoption theory may also inform how a

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[35] DHS Science and Technology Directorate, *Strategic Plan 2015–2019*.

[36] Dana Shea, *The DHS S&T Directorate: Selected Issues for Congress* (CRS Report No. R43064) (Washington, DC: Congressional Research Service, 2014).

[37] Global Centre for Public Service Excellence, *Design Thinking for Public Service Excellence*.

design-thinking model can be implemented within the organization. Rogers' Diffusion of Innovations theory describes how innovations, whether an idea or a technology, are adopted by individuals within a social system.[38] Rogers emphasizes the role of human capital and proposes four elements that influence the implementation of a new approach: "the innovation, communication channels, time, and the social system."[39] The Technology Acceptance Model is a theory that models how a user accepts and uses a technology. The two primary factors that influence a user's decision to adopt a new technology are perceived usefulness and ease-of-use.[40] Of note, these two adoption theories share the same human-centric principles espoused in design thinking. Both theories highlight the importance of involving the end user in the development process to increase the likelihood that a new technology is useful, adopted, and thus, directly impacts homeland security operations. A noted gap in the existing DHS S&T processes is an emphasis on the user from the beginning and continually throughout the solution development process.

A literature review of DHS S&T accomplishments and processes was challenging as much of the literature comes directly from DHS S&T in the form of strategic plans, testimony, and DHS website content. The lack of outside sources and studies make it difficult to determine what is documented versus what is actually used within DHS S&T.

3. How have other public organizations used design thinking?

A review of how design thinking is used by public organizations identified a series of initiatives. To inform how DHS S&T specifically can adopt design thinking two organizations are highlighted within the literature review. These two organizations, Denmark's MindLab, and the Defense Advanced Research Projects Agency (DARPA) are explored in detail as cases studies in Chapters IV and V.

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[38] Rogers, *Diffusion of Innovations*.

[39] Ibid.

[40] Viswanath Venkatesh, "Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model," *Information Systems Research* 11, no. 4 (2000): 342–65.

a. Innovation Labs

To understand the application of a design-thinking methodology better, public organizations using elements of the approach are reviewed. A common thread observed within the literature review was the linkage between design-thinking processes and innovation labs. While design thinking is not necessarily cited as the specific process a lab is using, many commonalities are observed to include collaboration with end users, a multi-discipline approach, and prototyping. While seeking public sector organizations using a design-thinking methodology provided additional insight into the rapid emergence of innovation labs, an effort was also made to identify other organizations applying the approach whether defined as design thinking or not. Table 1 provides an overview of established innovation labs around the world.

Table 1. International Examples of Innovation Labs

Government	MindLab (Copenhagen, Denmark) Centre for Excellence in Public Sector Design, (Canberra, Australia) National Health Service, Institute for Innovation and Improvement (Warwick, UK) The Social Innovation Lab (Kent, UK) NASA Centre for Excellence for Collaborative Innovation (Washington/Houston, U.S.)
Private sector with public service focus	Deloitte GovLab (Washington, U.S.) IDEO.org (various locations)
Not for Profit	Helsinki Design Lab, Sitra (Helsinki, Finland) MaRS Solutions Lab (Toronto, Canada) Participle London (London, UK) la 27eRegion, (France) The Public Policy Lab (New York, U.S.)
Universities	OCAD slab Harvard i-Lab (Cambridge, U.S.) d.school (Stanford, U.S.) MIT AgeLab and MIT Media Lab (Cambridge, U.S.) InWithFor (Adelaide, Australia)

From Teresa Bellefontaine, "Innovation Labs: Bridging Think Tanks and Do Tanks," Policy Horizons Canada, March 18, 2013, http://www.horizons.gc.ca/eng/content/innovation-labs-bridging-think-tanks-and-do-tanks.

b. Denmark's MindLab

Denmark's MindLab was established in 2002. While it has been in place for 13 years, an extensive amount of literature on the organization is not available. Similar to

DHS S&T, much of the research is based on reports by MindLab leadership and general interest articles. The MindLab is an interesting case as the organization has periodically adjusted its mission and structure since its inception to leverage what is working and to jettison what is not. In addition, MindLab sits at the intersection of three government departments and one local government. This unique situation parallels DHS S&T's position within DHS and the HSE, albeit on a smaller scale. While not an R&D organization, MindLab's mission is to involve citizens and businesses to create new solutions for society.[41] MindLab's longevity in practicing design thinking and imperative to connect with government staff and end users offers insight for DHS S&T to consider in adopting a design-thinking approach to problem solving.

While MindLab does not stress the term "design thinking," former MindLab Director Christian Bason spoke specifically on the challenges for government adoption of design thinking that are worth noting for the review of the DHS, MindLab, and DARPA approaches to problem solving within the case studies:

- Fostering and Executing Design—Although "labs," "centers," and "spaces" are proliferating within government, funding, organizational change, management buy-in, and solution implementation remain challenging.
- Design Expertise—Without in-house design expertise, the government relies on design consultancy. Design consultancy remains immature and has yet to focus on the public sector as a primary client. In addition, design education needs to catch up and designers need to understand better how to work with the government (or it could be argued the government needs to learn how to better work with designers).
- Disruption—Human-centered design forces a more collaborative and inclusive view of who needs to be involved in a process to make it work, which is inherently disruptive to the current public governance paradigm and the individuals who operate within it.[42]

[41] "About MindLab," accessed July 24, 2015, http://mind-lab.dk/en/.

[42] Christian Bason, "Design-led Innovation in Government," *Stanford Social Innovation Review* 11, no. 2 (Spring 2013): 15–17.

c. DARPA

One notable organization not referenced as an innovation lab yet recognized for its innovation is DARPA. As DHS S&T is frequently associated with DARPA, and the DARPA model continues to be used to establish relatively new government organizations, to include the Department of Energy's Advanced Research Project Agency—Energy (ARPA-E), and the Office of the Director of National Intelligence's Intelligence Advanced Research Projects Agency (IARPA), it was decided to review the literature to identify if a design-thinking methodology could be linked to DARPA's perceived successes within the R&D community.

Similar to innovation labs, literature was not found consistently tying DARPA's innovation practices to design thinking; however, known aspects of the DARPA approach appear to carry characteristics of design thinking. Additional research on the DARPA model draws direct parallels to the principles of design thinking and how DARPA is structured and managed.

While much has been written on DARPA's successes, the design-thinking process, coupled with an organizational assessment model, provides another perspective of the characteristics necessary to inform similar endeavors. DHS S&T is frequently compared to DARPA. The comparisons typically fall within two schools of thought. The first school of thought argues that DHS S&T should emulate DARPA based on its longevity and successes. The second school of thought argues against comparisons to DARPA, as the stated missions, parent organizations, and user bases, differ significantly. This thesis proposes that through a design-thinking lens, DHS S&T can identify and harness specific strengths of DARPA that could be emulated within DHS S&T while adapting those strengths to the end users and current R&D and homeland security environment.

4. Summary

The literature covers many activities grounded in design thinking and open innovation within departments and agencies throughout all levels of government, universities, and for-profit and not-for-profit entities. These activities are happening

domestically and internationally. Design thinking itself is not new; however, the use of design thinking within public-sector organizations, specifically with a homeland security focus, is a relatively new endeavor. The past years have introduced a host of terms and programs with the aim to spur innovation to include innovations labs, design thinking, skunkworks, lean startups, etc. An underlying goal of this thesis is to understand the linkages between these initiatives and practices. By understanding the application of methods to improve innovation and end use of products and services, DHS S&T can identify process solutions that factor in change management, organizational culture, and evaluation to ensure short-term progress and long-term impact on the homeland security mission.

D. RESEARCH DESIGN

To identify opportunities for a design-thinking approach within DHS, the research approach involves a comparative analysis of case studies. The first case study reviews the use of design thinking within Denmark via the MindLab. The second study reviews DARPA's approach to problem identification and solution through a design-thinking lens. A comparative analysis can inform the application and incorporation of a design-thinking methodology within DHS S&T's approach to R&D.

While originating in the private sector, design thinking has become more prevalent within the public sector to address a range of challenges. The selected case studies represent an established program within Denmark that ascribes to a design-thinking process and an established organization within the United States that does not cite a design-thinking model; however, its reputation and practices warrant a comparison to design thinking and DHS S&T. The studies focus on observations that could translate to the homeland security mission and the environment in which DHS operates.

While a design-thinking methodology can apply to any homeland security organization, the research focuses on the specific role of DHS S&T within the HSE. As noted in the Quadrennial Homeland Security Review (QHSR), DHS has an opportunity to service the HSE writ large through its programs and processes.[43] DHS S&T stands at

[43] Department of Homeland Security, *The 2014 Quadrennial Homeland Security Review.*

the intersection of homeland security and R&D, and can thus, set an example and provide leadership on evolving approaches to innovation.

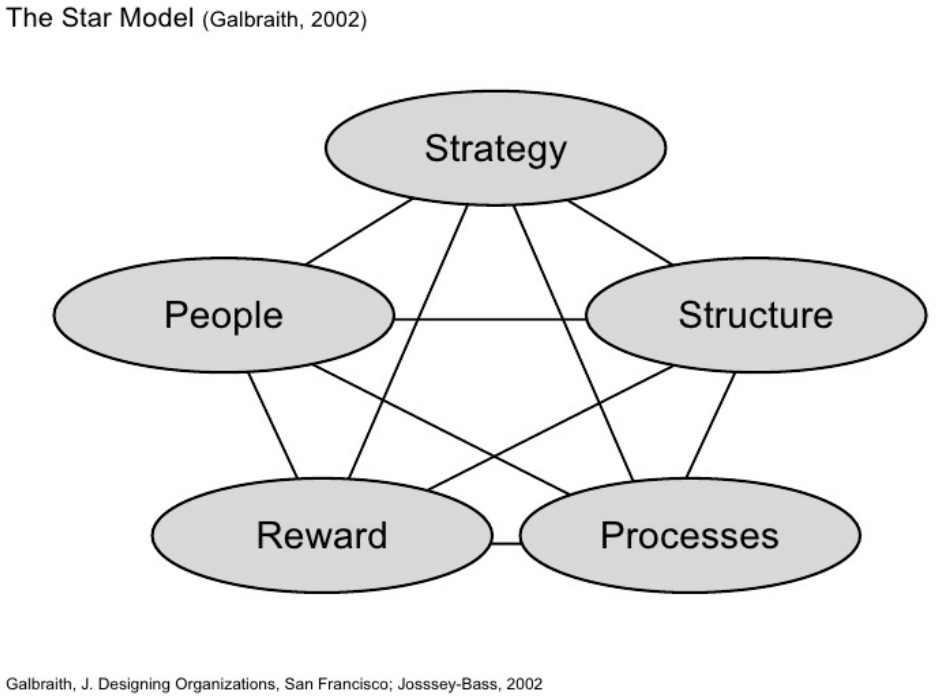
A series of factors based on Galbraith's Star Model are used to analyze how DHS S&T, MindLab, and DARPA apply design-thinking principles. The Star Model provides a framework for an organization to make choices that impact how an organization operates. The framework proposes a set of areas that in conjunction with one another can influence an organization's culture and individual behaviors. Galbraith's Star Model (Figure 4) consists of the following five areas:[44]

- Strategy: Specify the goals, objectives, values, and missions
- Structure: Determine the placement of power and authority with specialization, shape, distribution of power, and departmentalization
- Processes: Consist of a vertical process to allocate funds and talent and horizontal processes designed around workflows
- Rewards: Align employee goals with organization goals
- People: Identify the talent needed by the strategy and structure of the organization to implement its chosen direction[45]

[44] Jay R. Galbraith, *Designing Organizations* (San Francisco, CA: Jossey-Bass, 2002).

[45] Ibid.

Figure 4. Galbraith's Star Model



From Jay R. Galbraith, *Designing Organizations* (San Francisco, CA: Jossey-Bass, 2002).

The data used for the case studies is derived from available literature on design thinking in the public sector, as well as government reports and documents to include literature developed by S&T, DARPA, and MindLab leadership. The data is analyzed against a consistent set of factors (Galbraith's Star Model) to identify patterns of opportunity for design-thinking adoption within DHS. The end result of the analysis is a framework that identifies how the organization's attributes can be shaped to execute a design-thinking approach to problem solving.

E. THESIS ORGANIZATION

An overview of design thinking is included in Chapter II. Chapter III describes DHS's current methods for problem solving and collaboration. Chapters IV and V introduce the two case studies. The case studies review Denmark's MindLab and DARPA; specifically, how the two entities are pursuing a design-thinking approach

within their respective organizations. Chapter VI provides an analysis of how the two organizations compare with DHS S&T and can inform its adoption of design-thinking processes and tools. Finally, Chapter VII provides recommendations for consideration by DHS in the form of a framework that captures a holistic approach for integrating design thinking within homeland security efforts.

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II. DESIGN THINKING

This chapter describes the increasing use of a design-thinking methodology, specifically within the public sector. A common manifestation of a design-thinking methodology in the public sector is through innovation-based programs often referred to as "innovation labs." Federal organizations embracing the innovation movement include the U.S. Census Bureau, the Department of Housing and Urban Development, the Department of Health and Human Services, and NASA.[46] One of the first publicized labs, the Office of Personnel Management's (OPM) Innovation Lab, opened in 2012.[47] The Government Accountability Office (GAO) was concerned with a lack of evaluation measures to gauge the impact of the Innovation Lab; however, recent coverage of the Lab points to more tangible projects underway with the potential to improve the government hiring process.[48] The U.S. Agency for International Development (USAID) launched a Global Development Lab in 2014 under the leadership of former Google engineer and State Department adviser Ann Mei Cheng.[49] DHS recently established a new DHS Procurement Innovation Lab with the goal of streamlining and shortening the DHS procurement process.[50] The activity around design-thinking principles reinforces DHS S&T's exploration of how it could adopt a design-thinking methodology to address its mission. The USAID initiative merits attention by DHS S&T based on its R&D focus. The DHS procurement initiative may provide insight on how design-thinking principles are embraced by DHS leadership and staff.

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[46] U.S. EPA, OA, "Innovation across the Federal Government," accessed August 4, 2015, http://www2.epa.gov/innovation/innovation-across-federal-government; U.S. Government Accountability Office, *Office of Personnel Management: Agency Needs to Improve Outcome Measures to Demonstrate the Value of Its Innovation Lab* (GAO-14-306) (Washington, DC: U.S. Government Accountability Office, 2014).

[47] Ibid.

[48] Ryan McDermott, "OPM Looks to Improve the Entire Hiring Experience, Not Just USAJobs," *FierceGovernment*, accessed July 8, 2015, http://www.fiercegovernment.com/story/opm-looks-improve-entire-hiring-experience-not-just-usajobs/2015-05-21.

[49] Billy Mitchell, "USAID Taps Former Google Engineer to Lead Innovation Lab," *FedScoop*, December 5, 2014, http://fedscoop.com/usaid-taps-former-google-engineer-lead-innovation-lab.

[50] "DHS Procurement Chief: 'Let's Take Some Chances' to Innovate," accessed August 4, 2015, http://federalnewsradio.com/acquisition/2015/07/dhs-procurement-chief-lets-take-some-chances-to-innovate/.

Another government initiative grounded in design thinking is the U.S. Digital Service. The U.S. Digital Service was brought about after the challenges experienced with Healthcare.gov.[51] The Service is comprised of small groups that work with public servants to improve key government services. While focused on digital services, the U.S. Digital Service playbook aligns well with the user-centered tenets of a design-thinking methodology. The playbook includes 13 "plays" pulled from successful private and public practices to improve the delivery of digital services.[52] The plays highlight a user-centric and holistic approach that emphasizes an iterative and agile development process for developing solutions. The playbook recognizes government-specific factors, such as contracting, budget, and legal, and provides recommendations and additional resources for how to address and integrate these factors within project teams.

While a plethora of design-thinking-based initiatives are being established, some run by well-recognized Silicon Valley experts, these initiatives have yet to focus on complex homeland security-specific problems and the R&D necessary to address those problems. As DHS S&T explores design thinking, it may be worthwhile to engage with the innovation-based activities occurring in other organizations to identify best practices and lessons learned. For example, both the GAO OPM Innovation Lab report and the U.S. Digital Service echo the importance of performance metrics, while also acknowledging the challenge in developing metrics that capture the process of innovation. The USAID program and DHS Procurement Lab align with the DHS S&T mission and may provide additional insights for how DHS S&T can apply design thinking to solve problems. Partnerships with other organizations may also result in opportunities to leverage solutions developed for other similar problem sets.

As noted previously, a design-thinking approach is being embraced by public organizations to solve problems and improve user experiences; however, the term "design thinking" is not always specifically referenced. See Figure 5.

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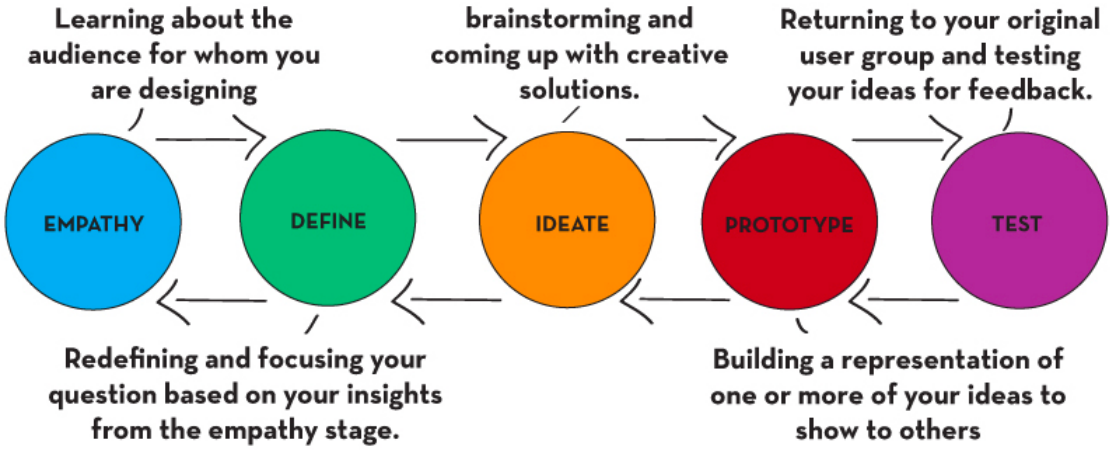
[51] The White House, "The Story of the U.S. Digital Service," Whitehouse.gov, accessed July 8, 2015, https://www.whitehouse.gov/digital/united-states-digital-service/story.

[52] The White House, "U.S. Digital Services Playbook," U.S. Digital Services, accessed August 15, 2015, https://playbook.cio.gov/.

Figure 5. Design Thinking Process Overview



From "Design Thinking," accessed August 16, 2015, http://createdu.org/design-thinking/.

The following sections analyze the key tenets of design thinking and align them with the Star Model's organizational attributes. This alignment demonstrates how design-thinking principles manifest themselves within organizations, even when the specific term is not used. Understanding this manifestation supports the case study analysis and provides a more holistic view of design thinking to inform its possible adoption within DHS S&T.

1. Design Thinking: Strategy

Creativity is at the heart of design thinking. To encourage creativity, the design-thinking methodology centers on the user experience. Design thinking can be applied to any situation; however, it lends itself to wicked problems. Wicked problems are open to a range of solutions. Comparisons can be made between design thinking and systems thinking. While both approaches lend themselves to wicked problems by viewing the interconnectivity of factors to understand possible solutions better, design thinking emphasizes the human within the problem-solving process.

DHS has a broad range of complex problems to which design thinking can be applied. DHS S&T could consider specific priorities when identifying potential problems for a design-thinking approach to provide a project team with a clear sense of the goals and objectives, and the necessary stakeholders to participate in the process.

2. Design Thinking: Structure

With an emphasis on brainstorming across disciplines and an iterative development process, design thinking relies on a flat rather than a hierarchical organizational structure. The process also relies on a diverse set of viewpoints and experiences that requires the ability to work across domains and organizational units. Walters warns of the challenge in promoting the cross-fertilization of ideas, particular in traditionally large and bureaucratic organizations like the federal government.[53] However, she offers that if an organization can foster the process, real value and skill can be obtained from embracing the chaotic and contradictory intellect of experts gathered from a variety of disciplines to tackle complex problems.[54] Whether flat or hierarchical, leadership support is important to ensure funding and resources and to enable cross-organizational collaboration. In addition, leadership support from participating organizations may improve the likelihood of adoption of proposed solutions.

Of note, a lot of the discussion around innovation and design-thinking centers on the physical space. Modular furniture, sunlight, white boards, Kraft paper, and a rainbow of post-it notes and markers are regularly associated with the design-thinking methodology. While it could be considered superficial, the environments popularly associated with design thinking are more understandable once familiar with the basic tenets of the design-thinking approach. To work collaboratively and encourage brainstorming across organizations or disciplines, a comfortable space that can expand or contract to meet the needs of a team is beneficial. Many organizations, to include DHS S&T, established "collaboration rooms." See Figure 6. A review of design-thinking principles may inform how to better use these spaces and consider how other workspaces are organized and used to support the adoption of design-thinking methods.

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[53] Helen Walters, "'Design Thinking' Isn't a Miracle Cure, but Here's How It Helps," Co.Design, accessed July 5, 2015, http://www.fastcodesign.com/1663480/design-thinking-isnt-a-miracle-cure-but-heres-how-it-helps.

[54] Ibid.

Figure 6. Collaboration Space

From "Calling Those Interested in Innovative Design," accessed August 16, 2015, http://williamrodick.tumblr.com/post/44534923527/calling-those-interested-in-innovative-design.

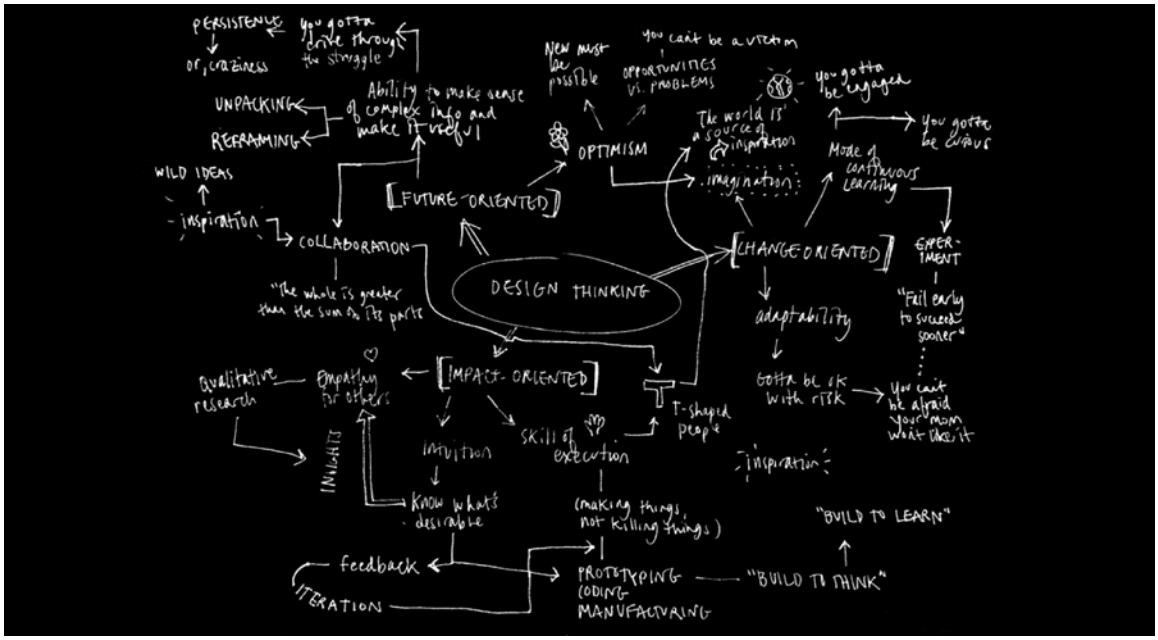
3. Design Thinking: Processes

While the literature frequently refers to "formal" when defining a design-thinking process to encourage creativity, as noted by Nussbaum and others, the process must not become so rigid that it stifles the creativity it was intended to spur. In addition to the general process, institutions, such as Stanford's Institute of Design, provide specific tools or method cards to exercise the process.[55] Design thinking emphasizes the entire user experience to include the adoption and use of a solution within an operational or policy realm. To build context and enhance communication around defining a problem and potential solutions, design thinking encourages the use of a myriad of tools that promote

[55] "Use Our Methods," accessed August 6, 2015, http://dschool.stanford.edu/use-our-methods/.

idea sharing. These tools are frequently visual, and a tool consistently observed when applying design thinking is rich pictures. Rich pictures are a visual tool to develop a shared understanding around a problem. Rich pictures evolved from the Soft Systems Methodology. At the core of the Soft Systems Methodology is understanding activities within a system in a way that is meaningful for all involved in the system.[56] Rich pictures provide a platform for developing a shared understanding and identifying gaps or contradictions within a system.[57] While rich pictures are an example of one tool, they provide a stark contrast to the engineering focused methodologies most commonly used within DHS S&T, and also provide an alternative to how DHS may be able to communicate better with end users. See Figure 7.

Figure 7. Rich Picture Example



From Dave, "Learn Warfighter Needs|theATHENAproject," January 20, 2015, https://athenanavy.wordpress.com/category/learn-warfighter-needs/.

[56] Peter Checkland and John Poulter, "Soft Systems Methodology," in *Systems Approaches to Managing Change: A Practical Guide*, ed. Martin Reynolds and Sue Holwell (London: Springer London, 2010), 191–242, http://link.springer.com/chapter/10.1007/978-1-84882-809-4_5.

[57] Andrew Monk and Steve Howard, "The Rich Picture: A Tool for Reasoning about Work Context," *Interactions*, March 1998.

While the design-thinking process is intended to cross vertical stovepipes and engage individuals with unique perspectives and skills, sponsorship is important. To adopt a design-thinking approach, leadership should be willing to provide the necessary resources and allow for some deviation from established processes. In addition, leadership should be able to influence other key decision makers within and outside of the organization to enable the cross-collaboration and flexibility necessary to harness the potential benefits of design-thinking processes.

4. Design Thinking: Reward

As a solution-based methodology centered on brainstorming across disciplines, design thinking provides an opportunity to engage, network, and learn from individuals with a diverse set of viewpoints. By focusing on problems deemed significant by one or more organizations, employees and leadership can be confident that efforts are contributing to an overarching objective. Design thinking is inherently project-based allowing for an individual sense of accomplishment aligned with organizational goals. While failures are expected, it is considered an inherent part of the process to identify the optimal solution to a given challenge. For an organization, such as DHS S&T, to adopt design thinking, it is important to consider how the rewards systems align with the tenets of design thinking. Collaboration and the option for failure should be incentivized within an organization's performance system.

5. Design Thinking: People

As design thinking emphasizes collaboration, it is important that participants are able to connect and work towards a common goal. The nature of design thinking also relies on project managers comfortable initiating and facilitating projects and tasks to address complex problems. The literature points to various tools and methods to aid individuals interested in applying design thinking to a specific project, but might not inherently possess the tools and skills. Design-thinking expertise and facilitation support can be outsourced; however, having a small team of experienced professionals may allow for a more repeatable process and instill the principles within an organization. Leadership support is important to recruit or procure design-thinking expertise to facilitate the work

of teams pursuing solutions to pressing problems. An organization seeking to adopt design-thinking principles may consider revisiting its workforce development strategy to include positions descriptions, training, and recruitment strategy to seek the skill sets that can best enable a design-thinking approach to problem solving.

6. Design Thinking: Summary

While slightly different, the basic tenets of design thinking remain consistent across the literature. The variation makes sense; as Walters notes, the reason that companies, such as Procter & Gamble and General Electric, are deemed successful adopters of a design-thinking approach is that they defined it according to their own terms, and factored in their respective organizational cultures.[58] By reviewing aspects of design thinking through the Star Model, a holistic approach is provided for S&T to consider how design thinking can be customized to best align with its mission, values, and workforce to spur new approaches to discovering and developing solutions to homeland security problems.

[58] Walters, "'Design Thinking' Isn't a Miracle Cure, but Here's How It Helps."

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III. DHS APPROACH

This chapter describes the current DHS S&T organization organized around the five elements of Galbraith's Star Model to compare current S&T practices based on the tenets of design thinking explored in Chapter II. This approach also allows for comparison to MindLab's (Chapter IV) and DARPA's (Chapter V) use of design-thinking principles within their respective organizations.

A. DHS S&T: BACKGROUND

DHS S&T was established through the Homeland Security Act of 2002 (P.L. 107–296). The Act gave the Under Secretary for DHS S&T a wide-ranging set of responsibilities. After 12 years, it remains difficult to assess DHS S&T's progress in achieving its many responsibilities to include the overarching mission to improve the homeland security posture via research, development, and transition. In addition to R&D, the organization is also tasked with assessing vulnerabilities and threats, operating five national laboratories, providing counsel to DHS and interagency leadership, supporting the DHS acquisition process, and executing a series of congressionally mandated programs, such as the Small Business Innovation Research Program and the Centers of Excellence organized around academic systems.[59] Not only is DHS S&T responsible for the Department's R&D agenda and internal coordination, but it is expected to be a leader throughout the federal government, industry, academia, and with state, local, territorial, and tribal partners in prioritizing and coordinating R&D capability gaps and ensuring the transition of R&D to homeland security operators. While S&T's responsibilities are varied, heavy emphasis is on producing innovative solutions that impact the security and resilience of the United States. S&T's dueling responsibilities warrant attention to how processes are used to address its different responsibilities. While design thinking can apply to a range of tasks, S&T may want to consider which specific programs and responsibilities lend themselves to design-thinking strengths in addressing complexity and enhancing collaboration to inform how it could adopt the approach within S&T.

[59] Homeland Security Act of 2002, 107th Cong., 2nd sess. (2002).

A series of initiatives exists to address some of DHS S&T's long-standing issues, and the shifting R&D landscape from a largely federal-government function to a largely private-sector function. One of the new initiatives is TITAN. The goal of TITAN is to discover and engage innovators that hold solutions, or portions of solutions for homeland security problems. An objective of TITAN is to link related programs and activities within DHS S&T to communicate priorities better and provide pathways for industry to connect with DHS S&T and homeland security operators.[60] The following elements comprise TITAN: experimentation, small business innovation research, futures and forecasting, prize authority, business accelerators, and engagement with industry, international, academia, and national laboratory partners. Design thinking is also noted as a TITAN element. Based on a review of DHS S&T's approach to problem identification and solution development, coupled with the initial literature review, it seems design thinking could serve as the "glue" for the various TITAN elements and the needed connection between initial problem identification, definition, and solution transfer, rather than as a distinct element. The following sections describe S&T's current practices aligned to each of the Star Model areas.

B. DHS S&T: STRATEGY

DHS S&T is tasked with delivering effective and innovative insight, methods, and solutions for homeland security practitioners.[61] Nieto-Gomez highlights the difference between incremental and disruptive innovation and the challenges each pose specific to the homeland security mission. Christensen defines incremental innovation, or sustaining innovation, as improving a product, program, or service using existing metrics whereas disruptive innovation results in an entirely new product or approach to a problem.[62] Nieto-Gomez proposes that homeland security institutions are dealing with incremental

[60] DHS Science and Technology Directorate, *Strategic Plan 2015–2019*.

[61] Ibid.

[62] Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail (Management of Innovation and Change)*.

threats; however, they are not positioned to address disruptive threats.[63] The delineation of incremental and disruptive innovation raises a question for DHS S&T on how it deliberately pursues incremental and disruptive innovation, as both are inherent within its mission and responsibilities. This deliberation can ensure design thinking is adopted appropriately for S&T and specific goals are clear for executing a design-thinking approach to specific problems or challenges.

DHS S&T was granted several unique authorities per the Homeland Security Act of 2002 to provide a disruptive innovation capability; however, the organization is largely driven by traditional systems engineering and acquisition processes used throughout the Department.[64] DHS S&T manages a variety of programs and mechanisms to include national laboratories, universities, public-private partnership agreements, a Small Business Innovation Research Program, long-range broad agency announcements, and other contract vehicles and programs to execute R&D.[65] While these mechanisms are designed to impact homeland security operations, the 2014 report, *The DHS S&T Directorate: Selected Issues for Congress*, notes that DHS S&T has experienced significant challenges in transitioning knowledge products and technology into operational environments.[66] Another challenge for DHS S&T is clear alignment of programs and tools with prioritized capability gaps, to include differentiating between incremental and disruptive innovation initiatives. The adoption of design thinking, combined with a clear understanding of DHS and HSE priorities and objectives, could support collaboration across disciplines, programs, and organizations to achieve incremental or disruptive innovation.

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[63] Rodrigo Nieto-Gomez, "The Power of 'the Few': A Key Strategic Challenge for the Permanently Disrupted High-Tech Homeland Security Environment," *Homeland Security Affairs Journal*, accessed April 19, 2015, https://www.hsaj.org/articles/50.

[64] Homeland Security Act of 2002.

[65] "Work with DHS Science and Technology," last published July 31, 2015, http://www.dhs.gov/how-do-i/work-dhs-science-and-technology.

[66] Shea, *The DHS S&T Directorate: Selected Issues for Congress*.

C. DHS S&T: STRUCTURE

DHS S&T is comprised of a large number of offices, programs, and areas of expertise resulting in a compartmentalized organization.[67] At the same time, authority remains centralized. This construct can be challenging for communicating and aligning efforts and for collaboration across organizations. New initiatives abound; however, the linkages and execution of these initiatives remains elusive. In addition to existing programs and offices, DHS S&T is creating a series of technology roadmaps for a set of Apex programs, as well as the visionary goals identified within the DHS Strategic Plan.[68] To support the Apex programs, technology engines are established. The engines are intended to foster collaboration across a series of common capabilities, such as identity management, social and behavioral science, and modeling and simulation. An understanding of design thinking's user-centered methodology and its alignment to the Star Model's organizational factors could inform DHS S&T structure changes needed to ensure new and existing initiatives and constructs improve and do not inhibit collaboration and development of new solutions and technologies.

D. DHS S&T: PROCESSES

While DHS S&T has used multiple methods since its inception to identify, prioritize, execute, and transition projects, no method is consistently embraced by the workforce. A consistent process coupled with clear communication of priorities could help S&T engage more meaningfully with end users and potential performers. Communication of problems and priorities would enable industry to connect with DHS and leverage existing or planned work to support the HSE. A consistent process that links priorities and funding to achieve objectives could help S&T more effectively engage with industry partners and end users to identify and transition technological solutions. In addition, coordination and collaboration across federal departments and agencies could identify opportunities to synchronize activities and projects.

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[67] "DHS S&T Organizational Chart," accessed August 21, 2015, http://www.dhs.gov/sites/default/files/publications/Visio-ST%20Org%20Chart%20-%202.pdf.

[68] DHS Science and Technology Directorate, *Strategic Plan 2015–2019*.

To identify and address increasingly complex problems within the homeland security mission areas, multiple disciplines should be engaged. As disciplines tend to have their own terminology and heuristic, a process to coordinate and elaborate on problems becomes important to enable collaboration across domains to identify and develop innovative solutions. As highlighted within the literature review, DHS S&T relies on a predominantly linear systems engineering approach to R&D, which does not lend itself to the wicked nature of problems within homeland security. The guides and tools used by S&T typically rely on individuals to be familiar with the terminology specific to traditional engineering disciplines. With an emphasis on collaboration amongst multi-disciplines, design thinking encourages plain language and the use of tools, such as pictures, sketches, and prototypes, to enable a common understanding of problems and potential solutions. This approach aligns well with government initiatives, such as the Plain Writing Act of 2010.[69] While the Act is focused on communicating benefits and services, it could be argued that plain language is a good practice within and outside federal departments and agencies, particularly when working with business, citizens, and experts within other domains. Design-thinking methods expand the toolsets available to enhance communication with end users and across disciplines. Adoption of a design-thinking process, combined with a clear set of priority projects and necessary resources, could improve the likelihood of innovative solutions transitioning to operators.

E. DHS S&T: REWARD

In the 2014 Federal Employee Viewpoint Survey, DHS scored 43 out of 100 for a results-oriented performance culture.[70] Within DHS S&T, performance plan standards are customized to each employee. This individual-based approach, coupled with a lack of project performance measures, can result in inconsistent and subjective assessments and difficulty in assessing not only employee performance but the S&T project portfolio and the organization's impact overall. An incentive for collaboration is inherent to design thinking, and requires its own set of knowledge, skills, and abilities. In addition, risk is

[69] Plain Writing Act of 2010, HR946, 124. Vol. 2861, 111th Cong. (2010).

[70] "2014 Federal Employee Viewpoint Survey Results," accessed July 24, 2015, http://beta.opm.gov/utilities/templates/general-content-page/.

not embraced within DHS S&T. Continued Congressional scrutiny of the organization's effectiveness has resulted in a rigid budget structure and an expectation of "quick wins." As a result, many of S&T's projects aim for short-term results that may not be significantly different from standard software development work conducted by the private sector for government programs. To adopt a design-thinking approach to projects, S&T may want to consider how it incentivizes the behaviors inherent within the methodology so that employees embrace and practice it.

F. DHS S&T: PEOPLE

As an R&D organization, DHS S&T is largely comprised of science, technology, engineering, and mathematics (STEM) professionals, which poses unique opportunities and challenges for design-thinking adoption and process change writ large. ICF International identifies the following profile characteristics for STEM leaders: tend toward cognitive, not interpersonal strengths; interpersonal relations and self-awareness are common development needs; high capacity and strong motivation to learn; and desire empirically sound data to demonstrate benefits of non-technical endeavors, such as leadership development.[71] These profile characteristics should not significantly differ from other R&D organizations. It does raise the question on how DHS S&T can diversify its workforce to communicate around complex problem sets and enable connections within and outside of the organization.

DHS continually highlights the importance of collaboration, diversity, and working across disciplines in doctrine to include the *Quadrennial Homeland Security Review* and the National Planning Frameworks.[72] The U.S. Office of Personnel Management's Strategic Plan references a 2008–2010 study of hiring trends with research showing that recruiting with an emphasis on cultural, experiential, and cognitive diversity may support an agency's ability to address "increasingly complex challenges

[71] Steven Aude, Michelle Paul Heelan, Daniel Fien-Helfman, and Anderson, Emily, "Cultivating Effective STEM Leaders: Challenges and Opportunities," *ICF International*, February 20, 2014.

[72] Department of Homeland Security, *The 2014 Quadrennial Homeland Security Review*; "National Planning Frameworks," accessed June 21, 2015, http://www.fema.gov/national-planning-frameworks.

more efficiently."[73] A design-thinking approach can better enable multi-disciplinary and interdisciplinary engagement between S&T's STEM workforce and homeland security operators and end users to solve wicked problems; however, it would require that DHS revisit how current staff are used on projects and develop a workforce development strategy. Design thinking emphasizes a user-centric iterative approach that is a departure from the current DHS S&T model. The approach could significantly assist DHS S&T with the challenge to develop and maintain collaborative relationships internally, and with the DHS components and the HSE.

A recent DHS S&T initiative that could be an enabler for staff to work across disciplines internally and externally is Emergenetics. Emergenetics is a personality profiling approach based on brain science. According to Browning, the goal is for individuals to understand their "thinking style (conceptual, social, analytical, or structural) and behavioral set points (expressiveness, assertiveness, and flexibility)."[74] By understanding their own approach and the approach of others, individuals can be more cognizant of how they approach new situations, accomplish activities, and how they can enhance relationships and better communicate with different types of personalities.[75] This type of initiative could support the design-thinking imperative to build a shared understanding of a problem space and the multitude of solutions that could address it. However, additional tools and training could be considered to support the existing workforce while revisiting future recruiting and hiring criterion. For design-thinking adoption within DHS S&T, it is important for the workforce to be prepared to execute it.

G. DHS S&T: SUMMARY

Table 2 summarizes DHS S&T's current organizational model to understand how design-thinking methods are embedded within the organization and inform how they could be further integrated in the future.

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[73] Office of Personnel Management, *Government-Wide Diversity and Inclusion Strategic Plan 2011* (Washington, DC: Office of Personnel Management, 2011).

[74] Geil Browning, *Emergenetics (R): Tap into the New Science of Success* (New York: Harper Business, 2005).

[75] Ibid.

Table 2. Summary of Design Thinking Processes within DHS S&T

Area	Description
Strategy	Homeland security mission is broad. S&T responsible for laboratories and acquisitions in addition to R&D. Emphasis on high-level visionary goals and detailed technical road maps and incremental innovation. Values communicated in recent Strategic Plan but supporting organizational elements not in place.
Structure	Hierarchical with a large number of compartmentalized programs, initiatives, and processes without defined relationships and outcomes. Centralized authority and frequent changes in priorities due to breadth of homeland security mission and emerging threats. .
Processes	Conflicting engineering focused workflows; not designed for wicked problems and not centered on end user or agile development. Funding not consistently aligned to priorities. Difficult to reallocate rapidly due to government budgeting process.
Rewards	Performance plans focus on individual rather than team or organization accomplishments and outcomes. Risk averse with a focus on incremental innovation. Collaboration is not incentivized.
People	Predominantly career civil service employees. Majority with a STEM profile. No strategic workforce development plan to align human resources and development with DHS priorities and processes.

The following two chapters review Denmark's MindLab and the Department of Defense's DARPA. The two case studies identify practices that can inform how DHS S&T transitions from its current organizational model to a model that enables the adoption of design thinking to solve complex homeland security problems.

IV. CASE STUDY: DENMARK'S MINDLAB APPROACH

The first case studied to inform potential shifts within DHS S&T to incorporate design thinking is Denmark's MindLab. MindLab is a foundational example of design-thinking execution within the public sector frequently cited in the literature. While not specifically operating in the homeland security mission space, MindLab provides an example of an established program operating across government organizations similar to DHS S&T's position within DHS and the HSE. MindLab's holistic approach that includes reviews of policy implications provides a different perspective from the more traditional R&D organization. The MindLab approach provides insight for DHS as the Department is comprised of multiple operational components and also requires collaboration with other federal departments and agencies, as well as the private sector and HSE. Both organizations operate in a complex environment in which technology adoption is often dependent on policy.

A. MINDLAB: BACKGROUND

MindLab was created in 2002 for Denmark's Ministry of Economic and Business Affairs as an internal incubator for invention and innovation.[76] MindLab leverages a design-thinking approach for innovation processes and collaboration across the public sector. MindLab supports three ministries and one municipality: the Ministries of Business and Growth, Education, and Employment, and the Odense Municipality, and also works closely with the Ministry for Economic Affairs and the Interior.[77]

MindLab continuously assesses its performance and priorities. Table 3 captures the evolution of MindLab since its inception in 2002.

[76] "MindLab."

[77] "Denmark's Mindlab Involves Citizens and Business in in Problem Solving with Government Ministries," accessed July 3, 2015, http://www.opengovguide.com/country-examples/denmarks-mindlab-involves-citizens-and-business-in-developing-new-solutions-for-the-public-sector/.

Table 3. Three Generations of MindLab

	First generation Creative platform	Second generation Innovation unit	Third generation Change partner
Process focus	Ideation	Value-creation	Insights to drive innovation
People	Employee-oriented	User-centred	User- and organisation-centred
Capacity focus	Training and facilitation	Innovation projects	Core business transformation
Tools	Creativity tools; emphasis on individual coaching etc	Research, project, facilitation tools; involvement of users + teams	Co-creation with users, professional empathy, rehearsing futures
Management	Management not involved	Management passively supportive	Management actively involved
Main role of design	Graphic design	Plus interaction design, service design	Plus systems design, organisation design, managing as designing
Key challenge	Buy-in to new ways of working	Integration of innovation processes in wider organisation	Adopting new narrative in the organisation

From Helle Vibeke Carstensen and Christian Bason, "Powering Collaborative Policy Innovation: Can Innovation Labs Help?" *The Innovation Journal: The Public Sector Innovation Journal* 17, no. 1 (2012): art. 4.

The following sections describe how MindLab embeds the principles of design thinking within the organization using the elements of Galbraith's Star Model.

B. MINDLAB: STRATEGY

MindLab's first five years were focused on organizational development and identifying efficiencies in administrative processes and workflows to increase productivity. A movement was underway to create additional MindLabs within individual units; however, leadership recognized the benefit in mutual learning and cross collaboration and a decision was made to form MindLab into a cross-governmental "centre of excellence" in user-driven innovation.[78] MindLab has gone through a series of

[78] Helle Vibeke Carstensen and Christian Bason, "Powering Collaborative Policy Innovation: Can Innovation Labs Help?" *The Innovation Journal: The Public Sector Innovation Journal* 17, no. 1 (2012): art. 4.

changes since its inception in 2002 to expand upon what worked well and to move away from what did not.

The organization focuses on societal problems that cross the government organizations it is designed to support. When initially established, MindLab did not adhere to a specific process. The process model is now explicitly anchored in design thinking, as well as qualitative research. As noted in Table 3, Mindlab is end user focused which can be seen in the organization's process for identifying projects in collaboration with the sponsoring organization and stakeholders. The strategy of aligning with and prioritizing projects in collaboration with key partners provides a parallel for DHS to consider in how it approaches projects with DHS components and end users. As design thinking is project based, it is important to have a strong foundation to ensure priorities and goals are understood and informed by all stakeholders to improve the likelihood of solution transition. An additional strategic lesson shared by MindLab is the importance of branding, and as such, it invests heavily in website development, identity branding, and internal and external communications to remain visible and relevant within its community.[79] As DHS continually refines its mission and priorities, it may want to heed the recommendation of MindLab to form and communicate intentionally an identity and strategic direction to potential partners and stakeholders.

C. MINDLAB: STRUCTURE

Mindlab maintains a lean organizational structure. MindLab is comprised of a small core staff and supplemented with project managers and part-time PhD students to encourage a dynamic environment that emphasizes research contributions, as well as problem solving.[80] Each staff person is typically responsible for managing two to three projects simultaneously. MindLab's periodic staff turnover could pose a challenge for strong social relationships within the organization; however, as noted previously, MindLab's emphasis on identity and brand may mitigate the negative aspects of

[79] Carstensen and Bason, "Powering Collaborative Policy Innovation: Can Innovation Labs Help?"

[80] "MindLab."

employee turnover by recruiting individuals prepared for the culture and mission of the organization.

Carstensen and Bason observe a bureaucratic tendency to keep the most promising and politically high profile projects siloed to control the process and perceived impact; they argue it is counterproductive.[81] They also espouse the importance of maintaining senior management support to ensure project relevance, and that results are usable and used. As DHS continually faces emerging threats and priorities, it is worth considering how new priorities are integrated within the organization. As Carstensen and Bason note, holding priority projects at the senior leadership level may be counterproductive. DHS S&T may want to consider its organizational construct and workflow to enable the continued integration of emerging priorities and management by equipped project teams. An organizational construct designed to be flexible could enable the adoption of a design-thinking methodology.

D. MINDLAB: PROCESSES

Possible problems for MindLab to tackle are initiated by government representatives and presented to the MindLab Board, which is comprised of senior staff from the various government organizations. A priority list is created and then sent for a second-level review. Once the second-level review is complete, recommendations are returned to the MindLab Board for discussion with the MindLab team, who make a final decision based on the following questions, presented in Table 4.

[81] Carstensen and Bason, "Powering Collaborative Policy Innovation: Can Innovation Labs Help?"

Table 4. MindLab Project Decision Criterion

MindLab Questions
Is the project core to the mission of the department, or is it offside?
Is it an issue that actually requires MindLab's expertise?
Is the focus and interest of the issue on the end user?
Does the issue require cross-sector collaboration?
Is there a "burning platform" that elevates this issue to the top of the agenda?

From Helle Vibeke Carstensen and Christian Bason, "Powering Collaborative Policy Innovation: Can Innovation Labs Help?" *The Innovation Journal: The Public Sector Innovation Journal* 17, no. 1 (2012): art. 4.

In general, project execution starts by reviewing the problem initially scoped by a municipal or ministry partner. MindLab then initiates a process that involves stakeholders, which for MindLab, commonly includes public officials, citizens, and business leaders. The goal of a project team is to ideate a slew of possible solutions and then prototype them. Sometimes, a pilot accompanies a prototype. Based on the findings of the prototype and possible pilot, a proposal is presented to the sponsoring ministries.[82] The scoping and planning process for a typical MindLab project is estimated at 12 months. A MindLab principle is to "do–don't only think" to enable communication and change mindsets.[83] This principle can be linked to the prototype phase of the design-thinking process. MindLab's emphasis on a flat organizational structure, while also maintaining an established process to ensure problem sets and solutions are driven by stakeholders, provides an example for how DHS S&T could approach project identification. The structured set of questions used by MindLab to select projects proposed by the sponsors provides transparency while also empowering MindLab to ensure that projects align with their mission and skills. Involving the sponsors and stakeholders at the beginning of the process may improve buy-in and the ultimate transition of solutions. MindLab admits challenges in transitioning innovations to the

[82] "Visit to Mind Lab," accessed July 8, 2015, http://www.servicedesignmaster.com/visit-to-mind-lab.html.

[83] Carstensen and Bason, "Powering Collaborative Policy Innovation: Can Innovation Labs Help?"

owners responsible for implementing solutions in the past;[84] DHS S&T faces similar challenges. While design thinking is not an immediate fix to the challenge of transition, the principles of design thinking may increase the likelihood of transition across DHS S&T's projects by building a shared understanding and relationship with stakeholders from project initiation through the final solution recommendation.

E. MINDLAB: REWARD

By focusing on seven to 10 projects a year, MindLab provides an opportunity for staff to set and achieve specific objectives within a reasonable timeframe that align with MindLab and sponsor priorities.[85] By employing a repeatable process for how projects are selected and formulated, employees can anticipate and understand expectations. The project-based approach ensures efforts have a beginning and an end. As prototyping is a key attribute of MindLab's design-thinking approach, failure is expected and encouraged in pursuit of an ultimate workable solution for a problem. MindLab's alignment to sponsor priorities, flat organizational structure, and project-based approach, combined with a strong identity, provide clear expectations for employees. To adopt a design-thinking approach, people are essential and DHS S&T could glean insight from MindLab on how to incentivize its workforce to embrace new approaches to creativity, such as design thinking.

F. MINDLAB: PEOPLE

Carstensen and Bason cite IDEO and GravityTank as examples they use for their own hiring criterion.[86] Tim Brown of IDEO seeks the following five qualities when hiring individuals: they say "we" more than "I"; they discuss failures, not just wins; they spent time teaching, as well as learning; they are nice to the receptionist; and they believe

[84] Carstensen and Bason, "Powering Collaborative Policy Innovation: Can Innovation Labs Help?"

[85] Patricia Kelly, "MindLab—A Danish Public Sector Innovation Lab and a Stage for Public Sector Collaboration," Australian Government Public Sector Innovation, June 28, 2010, https://innovation.govspace.gov.au/2010/06/28/mindlab-a-danish-public-sector-innovation-lab-and-a-stage-for-public-sector-collaboration/.

[86] Carstense and Bason, "Powering Collaborative Policy Innovation: Can Innovation Labs Help?"

in asking for forgiveness, not permission (encourage risks in developing an employment application package, i.e., video portraits, designed custom apps, etc.).[87]

MindLab pursues project managers from a variety of backgrounds to include business, sociology, anthropology, visual communication, design, and research.[88] MindLab leadership emphasizes recruiting and developing "likeable people."[89] The argument is that introducing significant change sometimes warranted to address complex problems requires the right type of personality that people will work with through challenges. The MindLab process centers on empowering staff and encouraging collaboration with individuals from a diverse set of backgrounds. The MindLab mission, scope, process, and flat organizational structure seem to be a draw for the types of employees the organization seeks. Establishing a clear identity and brand may support MindLab in setting expectations and recruiting the individuals it seeks. If DHS S&T pursues a design-thinking approach, how it recruits the necessary skills sets and builds an organization to nurture those skill sets may be an important factor to realize the benefits of a design-thinking methodology.

G. MINDLAB: SUMMARY

Table 5 summarizes MindLab's organizational model to understand how design-thinking methods are embedded within the organization to inform how DHS S&T could consider integrating similar practices within its organization.

[87] Tim Brown, "How I Hire: 5 Tips for Landing a Job at IDEO," *Design Thinking*, September 30, 2013, http://designthinking.ideo.com/?p=1195.

[88] "Employees," accessed August 7, 2015, http://mind-lab.dk/en/medarbejdere/.

[89] Carstensen and Bason, "Powering Collaborative Policy Innovation: Can Innovation Labs Help?"

Table 5. MindLab Summary

Area	Description
Strategy	Focus on wicked societal problems that are complex and open to interpretation and multiple solutions. Projects aligned with sponsors and scoped with stakeholders. Recognizes importance of communicating an identity and brand.
Structure	Small and flat organization with empowered program and project managers. Limited number of projects executed each year. Project managers support multiple projects.
Processes	Emphasis on horizontal workflows and collaboration outside of the organization. Clear process for identifying and executing projects.
Rewards	Employee goals aligned directly to set of projects resulting in clarity of expectations. Failures acknowledged as integral to the project process.
People	Recruits competencies not common within the civil service. Understanding of the political process and how the public sector operates. Provide mix of skills necessary for a human-centered approach.

After reviewing DHS S&T and MindLab organizational models, Chapter V analyzes the DARPA organizational model.

V. CASE STUDY: DARPA

Chapter V uses the same five analysis factors as Chapters III and IV to analyze how DARPA as an organization incorporates design thinking. DHS S&T is frequently compared to DARPA. DARPA is consistently lauded as an example of an innovative public sector organization. The continual comparison between DHS S&T and DARPA is logical as DHS S&T includes HSARPA, which was specifically called for within the Homeland Security Act of 2002 with characteristics resembling those of DARPA.[90] Over the past 13 years, DHS S&T (and HSARPA) has struggled to mirror DARPA's perceived successes. While continued debate occurs on how closely DHS should mimic DARPA when factoring in the diversity of the HSE and mission, DARPA's project model warrants attention. Through the lens of a design-thinking approach to problem solving organized by Galbraith's Star Model, this chapter identifies DARPA project practices and approach to disruptive innovation and how they may apply to DHS S&T's approach to problem solving.

A. DARPA: BACKGROUND

Much of the literature on R&D models to emulate points to DARPA. William Bonvillian describes the history of federal R&D dating back to World War II to the present where the DARPA model continues to be the standard 56 years after its creation.[91] Bonvillian ponders if the more recently established IARPA, ARPA-E, and other organizations will have an opportunity to fine tune the DARPA model. DARPA was created in 1958 in response to the Soviet Union's launch of *Sputnik*,. Its founding mission was "to prevent and create strategic surprise."[92] The founding mission aligns with disruptive innovation rather than incremental innovation. DARPA is situated within

[90] Homeland Security Act of 2002.

[91] William B. Bonvillian, "The New Model Innovation Agencies: An Overview," *Science and Public Policy*, 2013, 1–13. doi:10.1093/scipol/sct059.

[92] Regina E. Dugan and Kaigham J. Gabriel, "'Special Forces' Innovation: How DARPA Attacks Problems," *Harvard Business Review*, 2013, http://hbr.org/2013/10/special-forces-innovation-how-darpa-attacks-problems/ar/pr.

the Department of Defense (DOD); however, it is separated from the more traditional R&D and acquisitions activities managed within the individual DOD services.

The following sections review how DARPA has integrated design-thinking principles within the organization and how those practices could inform DHS's adoption of a design-thinking approach to problem solving within its organization. The sections are organized by the five areas of the Galbraith Star Model to enable comparisons between DHS S&T, MindLab, and DARPA approaches to problem solving and design-thinking principles.

B. DARPA: STRATEGY

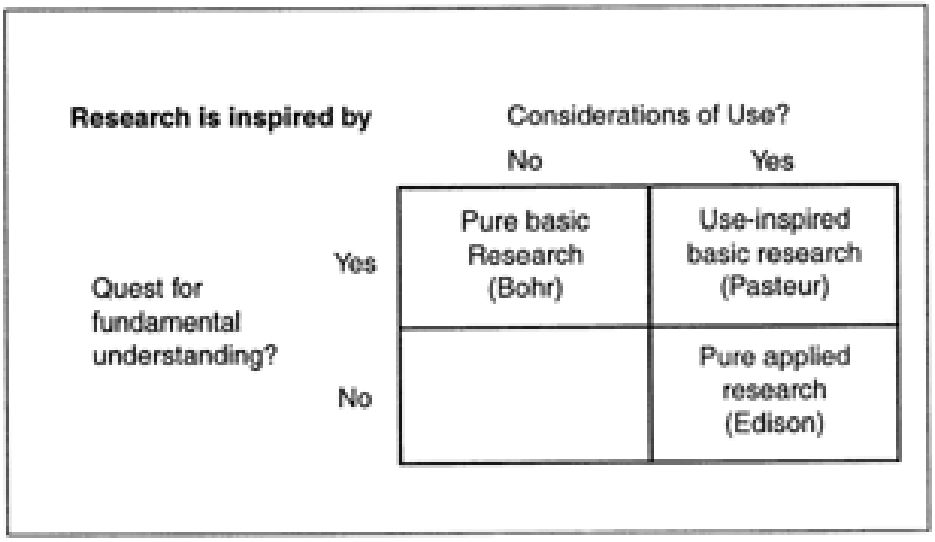
Dugan and Gabriel describe three primary elements of the DARPA model: ambitious goals, temporary project teams, and independence.[93] Dugan elaborates that DARPA pursues disruptive innovation and that traditional R&D technology road maps may hinder the delivery of breakthrough innovations. She proposes that DARPA succeeds because it is a small, dedicated, and independent organization focused on "use-inspired basic research."[94] DARPA commits to projects that fall in what political scientist Stokes described as "Pasteur's quadrant."[95] Pasteur's quadrant (Figure 8) eschews the notion of either solely focusing on pure basic research or pure applied research, and argues that scientific research can pursue both, and it is at this junction at which the government can make the most impact.

[93] Regina and Gabriel, "'Special Forces' Innovation: How DARPA Attacks Problems."

[94] Ibid.

[95] Ibid.

Figure 8. Quadrant Model of Scientific Research



From Donald E. Stokes, *Pasteur's Quadrant: Basic Science and Technological Innovation* (Washington, DC: Brookings Institution Press, 1997).

DARPA's ambitious goals translate well to design-thinking's strength in addressing difficult to define wicked problems. Ambitious goals also guide project portfolios, individual projects, and engage the interest of individuals to work the projects. Dugan offers that a project portfolio should include a healthy balance of two kinds of initiatives, "projects that are focused on new possibilities created by scientific advances and projects that are focused on solving long-standing problems through new scientific development."[96] While DHS S&T focuses on technology roadmaps, Dugan argues that the work in Pasteur's quadrant does not exist on roadmaps.[97] Weinberger highlights former DARPA Director Lukasik's warning that "without presidential challenges, DARPA is in danger of working on problems that are technologically interesting but not important to the nation."[98] "Once you move in that direction," Lukasik opines, "you move in the direction of more detail, and if that's the case, you run the risk of becoming irrelevant because your measure of survival is political adroitness rather than technical

[96] Dugan and Gabriel, "'Special Forces' Innovation: How DARPA Attacks Problems."

[97] Ibid.

[98] Sharon Weinberger, "Defence Research: Still in the Lead?" *Nature*, January 23, 2008.

excellence and solving important problems."[99] While Durgan forcefully argues for an emphasis on disruptive innovation and avoidance of roadmaps, Lukasik counters that alignment with specific priorities is important. The two former DARPA directors combined comments provide options for DHS S&T to consider in how to balance its portfolio of projects so solve problems of national significance.

C. DARPA: STRUCTURE

DARPA has autonomy in selecting and executing projects and is not wed to specific user requirements like the other DOD service R&D programs. Lee uses the term "skunkworks" to describe DARPA's well-funded research teams. He elaborates that when program managers are properly empowered, they create innovation communities that encourage cooperation and competition to achieve objectives.[100] Based on MindLab's position to Denmark's government organizations, it could also be considered a skunkworks construct. Dugan opines that the independence allows the organization to move quickly and take risks. This flexibility, in turn, helps DARPA recruit high performing individuals.[101] DARPA is comprised of approximately 250 personnel of whom 140 are technical personnel organized around relatively short-term projects. Fixed-term technical managers lead the projects.[102]

According to Fuchs, the DARPA approach introduces a form of technology policy in which government PMs "re-architect social networks among researchers so as to identify and influence new technology directions in the U.S. to achieve an organizational goal."[103] DARPA emphasizes a horizontal process to achieve objectives and maintains autonomy that allows leadership within DARPA to guide portfolio decisions and allocation of resources. The DARPA model highlights an identity challenge for DHS

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[99] Ibid.

[100] Peter Lee and Randy Katz, "Reenvisioning DARPA, ver. 6," *Computing Community Consortium*, 2008.

[101] Dugan and Gabriel, "'Special Forces' Innovation: How DARPA Attacks Problems."

[102] Ted Greenwald, "Secrets of DARPA's Innovation Machine," *Forbes*, February 15, 2013, http://www.forbes.com/sites/tedgreenwald/2013/02/15/secrets-of-darpas-innovation-machine/.

[103] Ibid.

S&T to consider, whether its mission and objectives align more closely to DARPA's skunkworks approach, or with the traditional R&D functions embedded within each of the DOD service organizations.

D. DARPA: PROCESS

In line with its position outside of the more traditional DOD R&D functions, DARPA DARPA projects do not "have to be tied to a specific need, and unlike grant agencies such as the National Science Foundation, it can fund risky ideas without going through peer review."[104] DARPA counters this risk by ensuring quantitative milestones so that likely failures are identified as early as possible. By clearly defining projects, DARPA maintains flexibility. If a project is not meeting the goals or technical challenges, it is expected to adjust. The organization is open to goals being overtaken by new discoveries. Project leaders are empowered to revise goals and reallocate resources as warranted throughout the project. It reflects DARPA's processes, as well as the emphasis on a flat organizational structure with decentralized decision-making authority.[105] With that said, a governance board process is used to make initial project approvals and to gauge progress periodically. While the linkage to specific user needs (in the case of DARPA the military) may not be as strong as other organizations, DARPA developed an approach to determining priorities. The Heilmeier Catechism, popularized by former DARPA Director George Heilmeier, can be found in use today in many organizations. Heilmeier's catechism consists of the following questions to determine the impact of a potential project, presented in Table 6.

[104] Weinberger, "Defence Research: Still in the Lead?"

[105] Dugan and Gabriel, "'Special Forces' Innovation: How DARPA Attacks Problems."

Table 6. Heilmeier's Catechism

What problem are you solving, in plain English?
How do you propose to solve it?
How is the problem managed today, and what are the limits of that approach?
What's different about your solution, and what gives you hope that I will succeed?
If your solution is successful, what impact will it have? How will that impact be measured?
How will the program be organized?
What intermediate results will it generate to help determine whether it's on track?
How will you measure its progress?
What will it cost?

When using the Heilmeier catechism, emphasis is often placed on "plain English" or "no jargon." This emphasis can also be seen in the design-thinking process and the importance placed on communication and ensuring all individuals involved in a project have a shared understanding and commitment to a problem. In addition to "plain English," design thinking also promotes the use of sketches and other tools to convey concepts visually and enable brainstorming. The Heilmeier Catechism emphasis on plain language, coupled with MindLab's recruitment of communication specialists, provide examples for S&T to consider in adopting a design-thinking methodology.

In 2008, Sharon Weinberger questioned the currency of the DARPA model. She argues that after 56 years, the DARPA model may warrant additional review and perhaps change.[106] However, Fuchs observes that DARPA has made adjustments over time. Prior to 2001, the DARPA PM's processes centered primarily on academia. She notes that since 2001, DARPA PM processes shifted toward new idea centers originating from

[106] Weinberger, "Defence Research: Still in the Lead?"

industry and specifically start-ups, while also still including academia. Fuchs argues that an over analysis of the DARPA organization and processes may cause an observer to overlook lasting, informal institutions embraced by DARPA PMs.[107] Colatat observes that a central understanding in DARPA is that innovation is a novel recombination of existing ideas and that collaboration increases the field of ideas and may introduce new ones. Collaboration also provides access to the range of skills necessary to complete a project.[108] The collaboration culture within DARPA stands in contrast to DHS S&T, perhaps due in part to the relative newness of the DHS organization and its mission. While design thinking is not specifically cited within DARPA processes, problem definition, ideation, and prototyping run throughout the descriptions of DARPA's processes. One aspect not highlighted by DARPA, but a centerpiece of the MindLab approach, is empathy with the end user. While DHS S&T should consider DARPA's emphasis on collaboration and leadership within the R&D community, it should also balance any approach to adopt design thinking with a focus on the end user based on DHS S&T's connectivity with DHS components and homeland security operators.

E. DARPA: REWARD

As highlighted by MindLab, identity and brand are important, and DARPA has created a strong identity and brand over the years. DARPA's reputation and focus on ambitious and well-defined projects draws talent to DARPA.[109] The flexibility in identifying and executing projects ensures PMs' interests are aligned with their work. An emphasis on quantitative project metrics, clear timeframes, and fixed term positions, PMs have a strong framework to execute against to achieve project goals, and in turn, the Agency's goals. To adopt a design-thinking approach to problems, DHS S&T should consider its ability to commit to a series of projects. Building communities that cross disciplines to solve complex problems requires trust. Design thinking can be useful to

[107] Fuchs, "Rethinking the Role of the State in Technology Development: DARPA and the Case for Embedded Network Governance," 1133–47.

[108] Phech Colatat, "An Organizational Perspective to Funding Science: Collaborator Novelty at DARPA," *Research Policy* 44, no. 4 (2015): 874–87.

[109] Dugan and Gabriel, "'Special Forces' Innovation: How DARPA Attacks Problems."

build and maintain trust. It may behoove DHS S&T to identify projects that allow a PM the opportunity to involve stakeholders from project formulation until its logical conclusion and build research communities around a challenge of national significance. Using a consistent project framework with quantifiable metrics that incorporates design-thinking principles and empowers the PM, serves to align individual performance with the organization's performance in developing and transitioning solutions to the HSE.

F. DARPA: PEOPLE

DARPA projects seek individuals who normally would not interact with one another to meet project objectives. A scientist may have many research avenues to pursue, while people in industry may encounter an aspect of the science needed for their application that hinders progress. Dugan proposes that including a diverse mix of individuals on projects teams produces an iterative cycle capable of breakthroughs in a short period of time.[110] Colatat introduces the term "collaborator novelty" to describe this diversity, as it relates to innovative technological outcomes. He defines collaborator novelty as a tendency of DARPA-affiliated scientists to initiate work with scientists with whom they have not worked before. He agrees with Dugan that collaborator novelty is associated with novel combinations of ideas and knowledge resulting in innovative research outcomes. He cautions that novelty for the sake of novelty should be avoided, and collaboration should be steered toward priority areas.[111] This sentiment echoes Lukasik's warning that DARPA maintain connectivity to national priorities.

Fuchs' observation that DARPA project managers "re-architect networks among researchers" to drive technology direction highlights DARPA's reliance on its people.[112] PMs are embedded in the research community to understand emerging themes and match them to needs, connecting disconnected communities, and maintaining the perspective

[110] Dugan and Gabriel, "'Special Forces' Innovation: How DARPA Attacks Problems."

[111] Colatat, "An Organizational Perspective to Funding Science: Collaborator Novelty at DARPA," 874–87.

[112] Fuchs, "Rethinking the Role of the State in Technology Development: DARPA and the Case for Embedded Network Governance," 1133–47.

necessary to integrate activities across an ecosystem.[113] DARPA's people are consistently highlighted as key to its success in building research communities and solving problems. Describing the qualities that DARPA seeks in hiring, Schnitzer includes technical excellence but elaborates on qualities, such as confidence, dynamic range, sense of urgency, and a strong desire to make a difference.[114] For DHS S&T to leverage the perceived success of DARPA, a DHS S&T workforce development strategy may balance or emphasize qualitative attributes, such as "likeability" espoused by MindLab with the confidence and sense of urgency sought by DARPA. Design-thinking principles, MindLab, and DARPA all recognize the importance of connecting with a diverse set of individuals to achieve ambitious goals.

G. DARPA: SUMMARY

Table 7 summarizes DARPA's organizational model to understand how design-thinking methods are embedded within the organization to inform how DHS S&T could consider integrating similar practices within its organization.

Table 7. DARPA Summary

Area	Description
Strategy	Ambitious goals, temporary project teams, and independence; use-inspired basic research.
Structure	Skunkworks construct focused on collaboration and empowered project managers. Autonomy to identify projects and reallocate resources based on performance.
Processes	Goal driven with pre-defined quantifiable metrics. Flexibility to change course based on project results. Rely on communities of practices developed by DARPA project managers.
Rewards	Ability to shape projects based on professional interests. With defined project metrics and milestones, objectives are clear and aligned with the organization. Risk is encouraged and failure is tolerated to achieve breakthroughs.
People	Developed a brand to entice goal-oriented individuals. Clear expectations. Term employees create a sense of urgency. DARPA's longevity and brand allows for a large network to recruit appropriate candidates.

[113] Ibid.

[114] Greenwald, "Secrets of DARPA's Innovation Machine."

After individually reviewing DHS S&T, MindLab, and DARPA's organizational approaches to design thinking, Chapter VI provides a summary of the analysis.

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VI. DESIGN THINKING PRACTICES ACROSS DHS S&T, MINDLAB, AND DARPA

Chapter VI summarizes the design-thinking practices of DHS S&T, MindLab, and DARPA to allow for a comparison between the three organizations. This summary informs the framework and recommendations in Chapter VII for how DHS S&T can adopt a design-thinking approach to solve wicked problems.

A. DHS S&T, MINDLAB, AND DARPA: DESIGN THINKING PRACTICES OVERVIEW

Both MindLab and DARPA demonstrate organizational characteristics closely aligned with the design-thinking methodology. The two organizations were identified based on the literature review of public organizations using the tenets of design thinking; however, it was surprising to observe how closely the organizational characteristics aligned with design thinking, as neither organization overtly identifies with the design-thinking methodology. An additional surprise is how far the current DHS S&T organizational model, across the five Galbraith Star factors, veers from the basic tenets of design thinking. It indicates that DHS S&T should carefully consider how to incorporate design-thinking tenets using a holistic view of the organization to enhance its likelihood of success in applying the approach to identify problems and transition solutions to end users.

B. S&T: DESIGN THINKING PRACTICES OVERVIEW

DHS S&T finds itself reacting to priority shifts and emerging threats, and to continued questions regarding its success in executing impactful R&D projects. Chapter III highlights the broad mission, as well as the multiple, and sometimes conflicting, responsibilities DHS S&T executes. Whereas MindLab and DARPA strategies, structures, processes, and workforce enable to a design-thinking approach, DHS S&T requires a significant organizational shift to embrace design thinking throughout the organization that may not be feasible in the near-term. However, an incremental approach leveraging the principles of design thinking, could demonstrate proof of concept and

begin positioning DHS S&T to make immediate changes that can influence the long-term direction of the organization.

C. MINDLAB: DESIGN THINKING PRACTICES OVERVIEW

As noted in Chapter IV, MindLab provides practices and anecdotes that can inform DHS S&T's integration of design-thinking methodologies within its own processes. MindLab has adjusted its strategy since its inception in 2002 to ensure it remains effective. This continual self-assessment is a valuable lesson for DHS S&T, as is MindLab's acknowledgement that metrics and measures are important to support a periodic assessment an organization's impact to inform its strategic direction. Metrics and measures also support the alignment of employee goals with organizational goals and provide an incentive framework for employees. MindLab has a rigorous process for soliciting, analyzing, and prioritizing projects before they are executed. This project-based process serves to align MindLab's success with its customer's success. This process deserves a review by DHS S&T as both organizations are uniquely situated to serve multiple government sponsors. MindLab highlights the importance of communicating its brand. To market and communicate an identity and brand, a clear and consistent mission, goals, and values are important. DHS S&T may want to revisit how it communicates its mission, goals, objectives, and values and organizational attributes recognizing that both MindLab and DARPA rely heavily on their identity and brand to manage expectations and to recruit best-in-class individuals to support their programs.

D. DARPA: DESIGN THINKING PRACTICES OVERVIEW

DHS S&T, specifically HSARPA, is frequently compared to DARPA. After completing the literature review and analysis, it is noted that the DARPA and DHS S&T missions, end users, and timescales are quite different; however, by using Galbraith's Star model, particular elements of DARPA's organizational construct are identified that may inform S&T's future direction. DARPA operates outside of the day-to-day R&D operations within the DOD. DHS S&T is responsible for informing DHS acquisitions, coordinating R&D, and pursuing incremental innovation through R&D. While DHS S&T is not precluded in pursuing disruptive innovation, its budget, other responsibilities, and

focus on near-term transition of technology to operators makes it a difficult focus area. With that said, DHS S&T could benefit from DARPA's practices by incorporating them within a revamped project construct. In addition, S&T could leverage DARPA's strength in building communities of practice by working more closely with DARPA and leveraging DARPA projects to address homeland security challenges. Through a renewed emphasis on external networking and collaboration, DHS S&T projects could significantly benefit from disruptive innovation in partnership with other organizations like DARPA, as well as industry.

E. SUMMARY OF DESIGN THINKING PRACTICES ACROSS DHS S&T, MINDLAB, AND DARPA

Table 8 summarizes how DHS S&T (Chapter III), MindLab (Chapter IV), and DARPA (Chapter V) incorporate design-thinking elements within their organizations, organized by the five elements of Galbraith's Star Model.

Table 8. DHS S&T, MindLab, DARPA Design Thinking Practices Summary

Area	DHS S&T	MindLab	DARPA
Strategy	Homeland security mission is broad. S&T responsible for laboratories and acquisitions in addition to R&D. Emphasis on high-level visionary goals and detailed technical road maps and incremental innovation. Values communicated in recent Strategic Plan but supporting organizational elements not in place.	Focus on wicked societal problems that are complex and open to interpretation and multiple solutions. Projects aligned with sponsors and scoped with stakeholders. Recognizes importance of communicating an identity and brand.	Ambitious goals, temporary project teams, and independence; use-inspired basic research.
Structure	Hierarchical with a large number of compartmentalized programs, initiatives, and processes without defined relationships and outcomes. Centralized authority and frequent changes in priorities due to breadth of homeland security mission and emerging	Small and flat organization with empowered program and project managers. Limited number of projects executed each year. Project managers support multiple projects.	Skunkworks construct focused on collaboration and empowered project managers. Autonomy to identify projects and reallocate resources based on performance.

Area	DHS S&T	MindLab	DARPA
	threats. .		
Processes	Conflicting engineering focused workflows; not designed for wicked problems and not centered on end user or agile development. Funding not consistently aligned to priorities. Difficult to rapidly reallocate due to government budgeting process.	Emphasis on horizontal workflows and collaboration outside of the organization. Clear process for identifying and executing projects.	Goal driven with pre-defined quantifiable metrics. Flexibility to change course based on project results. Rely on communities of practices developed by DARPA project managers.
Rewards	Performance plans focus on individual rather than team or organization accomplishments and outcomes. Risk averse with a focus on incremental innovation. Collaboration is not incentivized.	Employee goals aligned directly to set of projects resulting in clarity of expectations. Failures acknowledged as integral to the project process.	Ability to shape projects based on professional interests. With defined project metrics and milestones, objectives are clear and aligned with the organization. Risk is encouraged and failure is tolerated to achieve breakthroughs.
People	Predominantly career civil service employees. Majority with a STEM profile. No strategic workforce development plan to align human resources and development with DHS priorities and processes.	Recruits competencies not common within the civil service. Understanding of the political process and how the public sector operates. Provide mix of skills necessary for a human-centered approach.	Developed a brand to entice goal-oriented individuals. Clear expectations. Term employees create a sense of urgency. DARPA's longevity and brand allows for a large network to recruit appropriate candidates.

The Chapter VI summary of design-thinking practices across DHS S&T, MindLab, and DARPA informs the proposed adoption framework for DHS S&T in Chapter VII.

VII. DHS S&T ADOPTION FRAMEWORK

Informed by the case study summary in Chapter VI, Chapter VII proposes a framework to adopt a design-thinking process within DHS. The framework provides a holistic approach by using Galbraith's Star Model to identify key organizational attributes for DHS S&T to consider.

A. DHS S&T DESIGN THINKING APPROACH: STRATEGY

The design-thinking process is generally organized around the following steps: empathize, define, ideate, prototype, and test. The research and analysis shows success is most likely if the design-thinking process is used as a framework and customized to align with an organization's strategy and culture. Hewing too closely to a formal or specific design-thinking process may squelch the very aspirations that cause an organization to seek a design-thinking approach to solution development. Based on the organizational assessment of S&T, broad change is needed to shift the culture toward a multidisciplinary collaborative user-centered approach to problem solving. With that said, DHS S&T released a new strategic plan in 2015.[115] The plan specifically cites the importance of engaging with homeland security operators and industry to address challenges. The plan also speaks to building the next generation of homeland security professionals. A design-thinking approach could address and support the execution of the majority of priorities and goals within the strategic plan. Due to the amount of change necessary based on S&T's current construct, it is recommended that design thinking be introduced incrementally within a select set of projects to demonstrate a proof of concept and inform its further adoption by the organization. This approach would affect the change necessary at an individual level to realize a shift in the broader organization referenced in the macro/micro universal law of change.[116]

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[115] DHS Science and Technology Directorate, *Strategic Plan 2015–2019*.

[116] Moghaddam, *From the Terrorists' Point of View: What They Experience and Why They Come to Destroy*.

B. DHS S&T DESIGN THINKING APPROACH: STRUCTURE

A design-thinking principle is building multidisciplinary teams to engage with end users and partners to ideate around wicked problems. Based on a review of MindLab and DARPA, and the design-thinking literature, team building seems to occur more commonly in flat organizations with empowered PMs and leadership support, access to end users, and resources to execute a project and build a network. Innovation initiatives, such as design thinking, seem to flourish when they are applied in a "skunkworks" environment somewhat separated from normal business processes.[117] DHS S&T may want to consider these lessons if it is interested in applying a design-thinking approach to projects. As noted in Chapter III, DHS S&T is not structured to embrace readily a design-thinking approach to problem solving; however, a series of recent initiatives designed to connect S&T staff with homeland security practitioners better may provide an opportunity to apply a design-thinking methodology.

DHS S&T is establishing integrated product teams (IPTs) to provide a mechanism for the DHS operational components to organize around common functions. In addition, DHS S&T is exploring the concept of innovation centers to build stronger relationships with DHS components to support the transition of R&D projects and to pursue near-term solution identification (12–18 months) for emerging requirements.[118] The IPTs, coupled with the innovation centers, may provide an opportunity to review emerging challenges and address them with newly formed teams that may be well positioned to apply a design-thinking approach. Use of newly established IPTs and innovation centers could provide for a proof of concept to confirm support for a design-thinking approach to solve problems within S&T and the DHS operational components.

Alternatively, or in conjunction with the IPTs and innovation centers, DHS S&T could consider applying design thinking to "pop-up" initiatives built on emerging threats. These "pop-up" initiatives typically necessitate collaboration across disciplines and organizations to address complex issues quickly. Due to the urgent nature of these

[117] Rogers, *Diffusion of Innovations.*

[118] DHS Science and Technology Directorate, *Strategic Plan 2015–2019*.

requests, the solution approach is often architected by a select few individuals and managed by leadership, which Bason observes can be counterproductive.[119] Design-thinking methods could change the approach to "pop-ups" and perhaps, improve the quality and support of solutions.

C. DHS S&T DESIGN THINKING APPROACH: PROCESS

DHS S&T has introduced a series of new projects, initiatives, and processes to improve the quality, speed, and transition likelihood of its programs. While speed is important, and the organization is anxious to demonstrate delivery of impactful solutions into homeland security operations, it may want to consider the deliberation and trial and error often necessary to improve outcomes truly over the long-term and prepare to invest the time, attention, and resources. Another lesson from the design-thinking approach and the organizations reviewed is the need to develop and track metrics to gauge the impact of an effort.[120]

MindLab and DARPA have created processes and workflows centered on collaboration and a flat organizational structure. Both organizations maintain a clear, transparent, and consistent process for identifying projects. Another key tenet of both organizations and the design-thinking literature is developing pre-defined metrics during the project formulation stage. Project management processes empower project leaders to adjust course and reallocate resources as necessary to meet project goals. The design-thinking process relies on failure to identify the best solution to a problem. MindLab and DARPA both embrace failure as part of the project process. These process observations could warrant a significant shift in how DHS S&T identifies and executes projects, and incentivizes the workforce if it desires to emulate practices of organizations designed around innovation-driven approaches to solution development.

[119] Carstensen and Bason, "Powering Collaborative Policy Innovation: Can Innovation Labs Help?"

[120] Walters, "'Design Thinking' Isn't a Miracle Cure, but Here's How It Helps."

D. DHS S&T DESIGN THINKING APPROACH: REWARD

DHS S&T performance plans tend to be centered on individual accomplishments. Without a clear set of priority projects, defined measures and metrics, and traceability to resources, it is difficult to align employee goals meaningfully to organizational goals. A renewed focus on strategy, structure, and processes could improve the incentive structure for employees. Collaboration, and an end user centric approach, could be incentivized rather than individual performance within performance plans. In addition to collaboration, MindLab and DARPA accept failure as part of the innovation process. To shift the culture, innovation-specific measures could be introduced to encourage employees to try new ideas and approaches to problem solving. As both MindLab and DARPA have established processes, both organizations are able to align employee success to organizational success. The case studies demonstrate that employee performance and incentives are entwined with other organizational elements, such as strategy, structure, and process. DHS S&T could consider a holistic approach in how it designs processes and incentivizes employees to build an evolving, creative, user-centered culture to solve problems.

E. DHS S&T DESIGN THINKING APPROACH: PEOPLE

DHS S&T is predominately comprised of career civil service employees. This model is in contrast to MindLab and DARPA's reliance on individuals from outside of the civil service. With over a third of federal employees expected to be eligible for collecting retirement benefits in 2017, DHS S&T has an opportunity to revisit its workforce development strategy to include its recruitment approach.[121] The majority of S&T's project manager positions are centered on STEM expertise. Professional development planning is typically accomplished by the individual and focused on maintaining credentials in the current area of expertise rather than pursuing skills to improve collaboration with others outside their area of expertise to develop solutions. As a relatively new organization with a broad mission, DHS S&T does not have the strong

[121] Josh Hicks, "Fed-Worker Retirement Eligibility to Skyrocket by 2017, Report Says," *The Washington Post*, January 30, 2014, http://www.washingtonpost.com/blogs/federal-eye/wp/2014/01/30/fed-worker-retirement-eligibility-to-skyrocket-by-2017-report-says/.

brand and identity enjoyed by MindLab and DARPA. This lack of identity may inhibit its ability to recruit the next generation of homeland security practitioners it seeks. Without a clear sense of strategy and transparent alignment of organizational factors, such as structure, processes, and rewards to the organization's strategy, it can be challenging to manage expectations and recruit new employees, and fully utilize existing expertise.

For design thinking to be successful, meaning and value should be created based on an understanding of the DHS S&T workforce. Moghaddam introduces the concept of interobjectivity defined as "understandings that are shared within and between cultures about social reality."[122] By determining how the DHS S&T workforce applies meaning and value, mechanisms can be identified to promote the individual acceptance necessary to embrace a design-thinking approach.

In summary, DHS S&T should consider the following factors, presented in Table 9, to apply design thinking and initiate a new culture of innovation with DHS S&T.

Table 9. DHS S&T Design Thinking Adoption Framework

Area	Description
Strategy	Revisit prioritization and project selection process. Emphasize value of collaboration and how design thinking can help with its execution. Set clear goals and objectives for the organization. Set-up skunkworks for "pop ups." Emphasize design process rather than programs or organization to best align capabilities and expertise. Emphasize tech scanning and forecasting to understand where research and tech is going and help inform.
Structure	Consider a skunkworks approach to introduce design thinking. Wicked problems addressed through skunkworks and design thinking; more traditional and day-to-day operations can continue to run in parallel.
Processes	Establish a consistent and transparent processes to include priority setting and project selection and execution. Revisit the key tenets of design thinking and how they can be incorporated and emphasized within processes to support the DHS S&T Strategic Plan.
Rewards	Performance Plans should be designed around group or team goals focused on the impact of projects and programs on users (outcomes). Rethink project

[122] Fathali M. Moghaddam, "Interobjectivity and Culture," *Culture & Psychology* 9, no. 3 (September 1, 2003): 221–32. doi:10.1177/1354067X030093004.

Area	Description
	and individual performance metrics to address innovation-related metrics, collaboration and acceptance of failure.
People	Leverage hiring authorities and establish workforce strategy, priorities, and recruitment methods to attract complementary skill sets. Look for a mix of individuals with the right personalities to bridge research domains. Have skunkworks opportunities be a perceived reward. Temporary rotations.

F. DHS S&T DESIGN THINKING APPROACH: CONCLUSION

Rather than a passing trend, an in-depth review of design thinking, coupled with a series of case studies, confirms the promise the approach could bring to DHS S&T. While DHS could purchase services from a few of the profile design-thinking practitioners, such as IDEO or Stanford, the promise of design thinking is its application to a particular problem, and how it could be integrated within an organizational culture to spur creativity in general. The DHS mission and stakeholder community is immense, and the threats and problems are innumerable. The makeup of the homeland security enterprise, and the complex nature of its problems, lends it to the methods and tools of design thinking. To support the homeland security enterprise, DHS S&T must be able to refine and improve tools and processes continually, think outside of traditional solutions, adapt quickly, and work across disciplines and geographic areas. A design-thinking model could impact projects immediately and positively shape the organization's culture over time.

DHS has an opportunity to use design thinking to synchronize initiatives and position it as a leader within the innovation space. Simons, Gupta, and Buchanan note that by adapting design-thinking insights and methodologies, an R&D organization stands to increase the speed, inventiveness, and vitality of their outputs and promote growth.[123] DHS S&T is building a series of programs to support its mission and this thesis proposes that a consistent process to link and leverage programs and expertise is available within the design-thinking approach. A strong and consistent relationship with end users and partners internally and externally has remained elusive for DHS S&T. A

[123] Simons, Gupta, and Buchanan, "Innovation in R & D: Using Design Thinking to Develop New Models of Inventiveness, Productivity and Collaboration," 301–7.

design-thinking approach emphasizes innovation and ensures the end user is fully engaged throughout the process to inform an end result. By emphasizing the end use of a product or service, design thinking also holds the promise of improving DHS's rate of technology transition and impact on the homeland security and resilience. While the research question focused on DHS S&T, it is hoped other organizations may be able to apply the practices captured within their own organizations.

> Our work is not the eradication of wicked problems but rather the hope and belief that we can do better.[124]

[124] Allyson Hewitt, "Report on MindLab," Canada: Social Innovation Generation, March 2012, http://sigeneration.ca/documents/MindLabReportMarch2012.pdf.

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